CLEAN WATER

WATER POLLUTION CONTROL RESEARCH SERIES ● 16110 FRU 12/71-10

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The River Basin Model:

HIGHWAY DEPARTMENT

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The RIVER BASIN MODEL is not primarily a water management model. Through human interaction and computer simulation, it and its users represent the major economic, social, and governmental decision-making which causes a regional system to function and change on a year-to-year basis. As part of the functioning of this system, water is demanded by industries and municipal water suppliers and pollution is generated by manufacturing and commercial activities, by people, and by farm activities. A gaming format is employed; model users provide inputs to the computer programs on behalf of business activities in the Economic Sector, groups of people or population units in the Social Sector, and government departments in the Governmental Sector. The Governmental Sector and the model required by its Highway Department are described. A principal function of the Governmental Sector is to provide public services, and its participants are elected and appointed public officials. The Highway Department has the responsibility for two types of transportation decision-making: Building and maintaining the highway system within the jurisdiction; and building transportation terminals to be used by local business for shipping and receiving. (Bell-Cornell)

(See also W72-11307)

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The RIVER BASIN MODEL:

Highway Department

by

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for the
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I. INTRODUCTION TO THE MODEL

A. Brief Description of the Model

In a sense, the RIVER BASIN MODEL is a misnomer because if one places an emphasis on "River" it leads one to believe that the model is primarily concerned with water management. The emphasis should be placed on "River Basin", and that term should be interpreted in its broadest context as meaning a geographical area of land. Through its two major components -- human interaction and computer simulation -- the model represents the economic, social and governmental activity that takes place within the geographical boundaries defined by the river basin or more simply by a group of continguous counties.

The model is unlike most other simulation or human interaction models. It was not designed to accomplish any one specific purpose. Rather it was designed to let its users represent the major economic, social, and governmental decision-makers who cause a regional system to function and change on a year-to-year basis. As part of the functioning of this regional system, water is demanded by industries and municipal water suppliers and pollution is generated by manufacturing and commercial activities, by people, and by farm activities.

The model is a computer-assisted decision-making tool, in which a number of computer programs simulate major processes that take place in the local system such as migration, housing selection, employment transportation, shopping patterns, the allocation of leisure time, and water quality determination. Users of the model provide inputs to these programs on behalf of business activities in the economic sector, groups of people or population units in the social sector, and government departments in the government sector.

Normally, the users of the model are assigned decision-making responsibility for businesses, population units, and government departments in a gaming format. This means that users become members of teams that are assigned control of:

1. Economic Assets: cash, land, manufacturing plants, outside investments, commercial activities, and/or residences.

2. Social Assets: population units that are designated as high income, middle income, and/or low income.

3. Government Assets: power of the budget, taxing and assessing authority, service responsibility, and planning and regulatory power.

The computer print-outs for a year provide a detailed description of the regional area represented by the model, and the users of the model evaluate this status as individuals, as team members, and collectively to define problems, establish objectives, develop strategies, implement plans, and react to feedback from the new computer printout for the next year.

The initial starting position shows a particular set of allocations of the locals system's resources and their effects on the status of the local area. The users of the model evaluate their own particular status within the local system as well as the status of the area as a whole. They then interact with one another in a dynamic decision-making environment in which they collectively have control over the local water quality decisions that will be made, implemented, and reacted to. Some of the model players may have apparently only marginal interests in the local water quality issues because they are pre-occupied with running schools, building roads, earning incomes, producing manufactured goods, building housing, and supplying local goods and services. Others will have maybe more interest as they attempt to be elected into public office, run the planning department, collect taxes, recreate, and develop a generally pleasant environment for their new residential subdivisions. Still others might have a direct and pressing interest in the local water quantity and quality as they attempt to set and enforce water quality standards, supply municipal water, use surface water in their production process, and benefit from major water-based recreation areas.

In short, the entire local system is represented by the model and its users, and water decisions are placed within their realistic context of having different importance to different individuals as a fur ion of their occupation, location, resources, and personal inclinations.

B. The Three Sectors

The model contains three basic decision-making sectors: economic, social and public. (Figure 1) Every city or region contains these three vital sectors whose interactions cause the area to function and to either grow and prosper or stagnate and decay. Decisions made by one group ultimately affect others

Figure 1

THREE DECISION-MAKING SECTORS AND CONSTITUENT TEAMS

ECONOMIC TEAMS
(Identified by single letter codes: A, B, C, etc.)

INDUSTRIAL DECISION-MAKER

- HI-Heavy Industry
  - FL-Furniture and Lumber
  - SG-Stone Clay and Glass
  - MP-Primary Metals
  - MF-Fabricated Metals
  - NL-Nonelectric Machinery
  - EL-Electric Machinery
  - TE-Transportation Equipment
- LI-Light Industry
  - FO-Food
  - TA-Textiles and Apparel
  - PA-Paper
  - CR-Chemicals, Plastics and Rubber
- NS-National Service

COMMERCIAL DECISION-MAKER

- BG-Business Goods
- BS-Business Services
- PG-Personal Goods
- PS-Personal Services

RESIDENTIAL DECISION-MAKER

- RA-Single Family
- RB-Garden Apts. and Duplex
- RC-Multiple Unit and High Rise

GOVERNMENT TEAMS
(Identified by the specific code preceding the department name)

- CH-Chairman of Jurisdiction
- CO-Councilman
- AS-Assessment and Finance
- SC-School
- MS-Municipal Services
- UT-Gas, Electric, Water and Sewer
- HY-Highways
- BUS-Bus Company
- RAIL-Mass Transit Agency
- PZ-Planning and Zoning

SOCIAL TEAMS
(Identified by double letter codes: AA, BB, CC, etc.)

- PH-High Income
- PM-Middle Income
- PL-Low Income

and one group often works against another group to achieve its goals. For example, proposed commercial developments by an economic group in a predominantly residential area can be blocked by residents of that area just as proposed changes by the government departments can be opposed by those participants in the economic or social sector.

1. The Economic Sector

Economic decision-makers are those businessmen who operate industrial, commercial, residential and farm establishments. Upon receiving output at the beginning of the round economic decision-makers review their economic status and make decisions for the present round. The various economic activities in the model have the following characteristics:

Basic Industry

Heavy Industry, Light Industry and National Services spend money for business goods and business services, utilities, a labor force, transportation, and taxes. In order to produce basic industry output which is then sold to the national markets at prices determined by national business conditions (the computer), owners of basic industries can make a wide variety of decisions. These decisions include purchasing land, changing salaries or maintenance levels, boycotting business goods and business services establishments, acquiring laons, building new businesses, upgrading existing businesses, demolishing old ones, and treating effluents that are dumped into the local water system.

The basic industry of the economy can be further subdivided into the following categories:

HI - Heavy Industry

- FL - Furniture and lumber
- SG - Stone, clay and glass
- MP - Primary metals
- MF - Fabricated metals
- NL - Non-electrical machinery
- EL - Electrical machinery
- TE - Transportation equipment

LI - Light Industry

FO - Food
TL - Textile, apparel and leather
PA - Paper
CR - Chemicals, plastics, and rubber

NS - National Services

Commercial Establishments

Business goods (BG) and business services (BS), personal goods (PG) and personal services (PS) spend money on many of the same items as basic industry in order to maintain a level of service capacity. This service capacity is consumed or partially consumed by local customers which include: the industrial sector, other commercial establishments and the population units (Pl's) who live in the city. Owners of the commercial establishments may make most of the decisions that owners of basic industries make in addition to setting prices for their products.

Residences

Single-family (RA), townhouse (RB), and high-rise (RC) residence units spend money on personal goods and personal services, utilities, and taxes, and earn income based on rent charged and the number and type of occupants residing in their housing units. Owners of residences may make the same types of decisions made by owners of basic industry in addition to setting the rent paid by their tenants.

Farms

Farm owners make very few decisions aside from how their land will be utilized and what level of fertilizer use they will employ.

2. The Social Sector

Decision-makers in the social sector represent the citizens who live and work in the simulated area. People are represented in terms of population units (Pl's). Each population unit represents fixed numbers of people (500). Population units are divided into three socio-economic groups: high income (PH), middle-income (PM) and low-income (PL). Because each class possesses its own expectations and behavioral patterns, each will have different preferences for residence, job, and schooling, etc. Social decision-makers can vote on behalf of the Pl's which they represent. Voting power is dependent upon the number of

population units controlled, the number of registered voters in each, and their socio-economic class. Social decision-makers can also direct the population units under their control to boycott places of employment or shop locations. Social decision-makers can also allocate leisure time of their population units to be spent in any of four basic activities: extra work, adult education (public or private), politics, and recreation. The amount of time spent on each of these activities has an effect on the socio-economic status and/or the dissatisfaction index of people living within the city.

A significant part of the model centers around how Pl's function within the local system during the course of each round of play which represents one year of time in the local area. Figure 2 shows the actions of Pl's as they are affected by the major operating programs.

3. The Public Sector

In the model, the government sector deals with the problems of education, highways, municipal services, planning, zoning, utilities, water supply and quality and bus and rail transportation. The public sector is divided into two basic components. The first component includes elected officials: the Chairman and the Council. These officials are elected by the social decision-makers representing the people who live in each jurisdiction. The Chairman and Council set tax rates, approve budgets, grant subsidies and appropriations, and make appointments. Appointed officials named by the Chairman are heads of these six governmental departments: Assessment (AS), Schools (SC), Municipal Services (MS), Highway (HY), Planning and Zoning (PZ), and Utilities (UT). The Bus and Rapid Rail Companies are semi-private organizations which also may be appointed by the Chairman. Players representing these departments make decisions which include allocating capital and current funds, changing salaries and maintenance levels, requesting federal-state aid, changing district boundaries, constructing or demolishing public buildings, upgrading public buildings, changing levels of service, and transferring cash between accounts.

Figure 2

Example of How Population Units Are Affected by the Major Operating Programs of the Model

Major Operating Programs	Effect on Population Unit
Migration	Pl's move to the local system, find and change housing within the local system, leave the local system
Water System	Poor water quality incareses dissatisfaction and high coliform count increases health costs and time lost due to illness.
Depreciation	Housing that depreciates becomes less attractive in the migration process.
Employment	Pl's are assigned to full and part time jobs that maximize net income (salary minus transportation costs), employers search for best educated workers.
Transportation	Pl's travel to work by the mode and route that minimizes total costs (dollar plus time), Pl's travel to shopping along the minimum cost routes.
School Allocation	Students of Pl's are assigned to public or private schools based upon the quality of public schools.
Park Allocation	Pl's are assigned to parks within a specified distance of where they live.
Time Allocation	Involuntary expenditures of leisure time are calculated as a function of the success of getting part time jobs, public adult education and the time spent on transportation.
Commercial Allocation	Pl's are assigned to stores at which the total costs are minimized (price plus transportation to the store).

C. The Water Component

The water component is a subsector that, in a sense, cuts across the other three sectors or is a part of each. For example, some of the industrial activities in the economic sector use surface water in their production process and all other economic businesses have some need for municipally supplied water. Population units in the social sector use water as a function of their income class and the type of housing they inhabit. In the government sector, the Utility Department is responsible for supplying the municipal water needs of the residents of its jurisdiction.

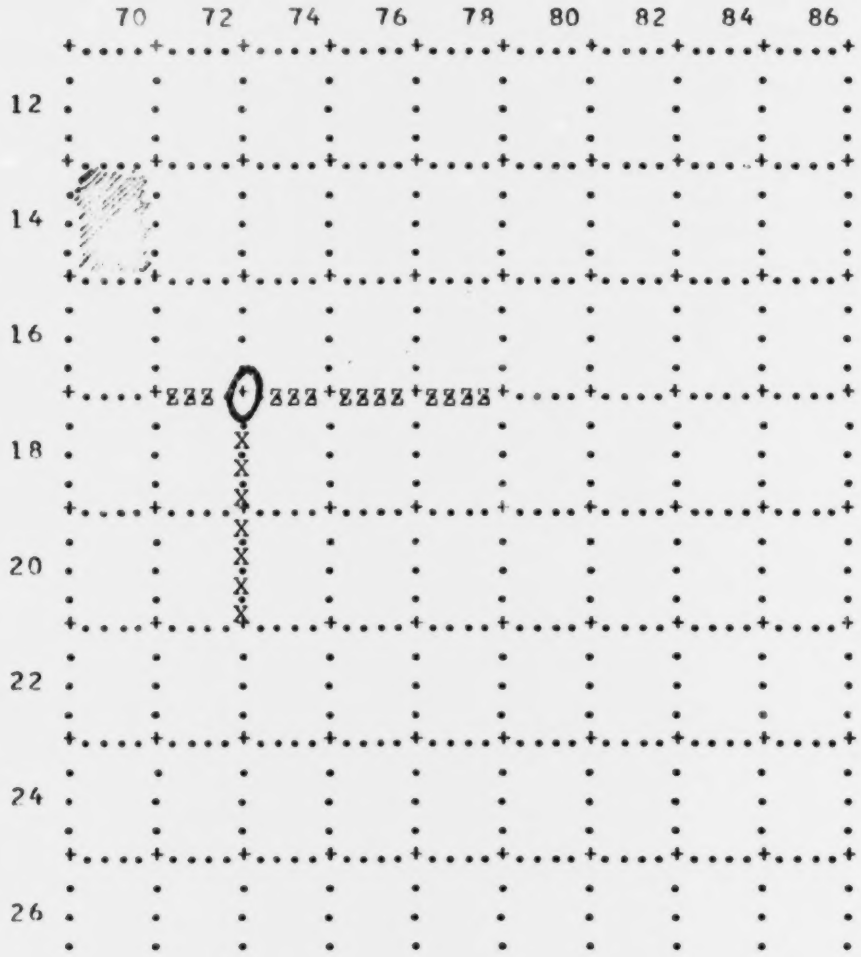
Each of the surface water users requires a specified quality of water and must either treat the water they intake or purchase water from a source outside of the local system. Every water user adds some pollutants to the water it returns to the water system. If left untreated, these water discharges may lower the quality of water of the body of water into which they are dumped. Since water users and polluters are located in a geographical space, acitivities upstream and downstream are affected differently by the dynamically created water quality conditions.

D. The Local System

The particular regional configuration being used is represented on a grid map consisting of 625 squares. Each square is of equal size and represents 6.25 square miles, 2.5 miles on a side. The grid and all of the computer maps are keyed to a coordinate system. Each parcel can be identified by its coordinates. Horizontal coordinates range from 70 to 118 and vertical coordinates from 12 to 60. Intersections are identified by the odd-numbered coordinates and highways are identified by even-odd (east-west) or odd-even (north-south) coordinates. In all cases, the horizontal coordinate (i.e., the larger number) is identified first.

For example, on the map in Figure 3 the shaded parcel is identified as 7014. Further, the four mile highway indicated by ZZZ is identified as 7217, 7417, 7617, 7817, while the two mile highway indicated by XXX is identified as 7318, 7320. The intersection marked by 0 is located at 7317.

Figure 3



E. The Unit of Time -- A Round

In the model, a round represents a year of change in the life of the simulated area. From the standpoint of the participants, however, a round may be thought of as a decision-making cycle which starts when they receive their computer output and ends when they hand in their decision input forms for processing by the computer.

During the early part of the typical round, decision-makers will be simultaneously reviewing their computer output and attempting to organize their possible actions. Economic decision-makers, for example, will probably attempt to acquire parcels of land that look good for future development purposes. They may attempt to secure loans from local or outside sources, apply for zoning changes, request utility expansions, and lobby for increased highway access. At the same time, social decision-makers might be bargaining for higher wages, requesting improvements in local schools and municipal services, lobby for higher water quality in the local river, and trying to promote those politicians who see things their way.

Meanwhile, the governmental decision-makers may be receiving requests from the economic and social decision-makers to lower taxes, improve schools, provide better municipal services, expand highways, build additional utilities, enlarge the park system, and improve other services. Budget officials are faced with the task of finding additional revenue to meet expanding public needs and dividing appropriations among the many local departments, all of which have attempted to justify their expanding budgets. Also the government office concerned with water quality might be pressuring the polluting industries to treat their wastes or face regulatory action. All water users might be concerned with water quality and quantity in so far as it affects their cost of using water and doing business.

Toward the middle of the round, it becomes clear to many decision-makers that all of their requests will not be granted. Thus, trade-offs and bargains must be made. Elected officials will begin to worry about staying in office. Departments must often plan to operate with less funds than they had requested. Low income representatives attempt to make their political power felt. High-income representatives attempt to maintain their status. Businessmen begin to look for short-cuts to reduce their losses and increase their activity and profit-making ventures. The water quality office begins to act upon its earlier threat.

As the round approaches a conclusion, the participants formalize the bargains they have made, continue to fill out their decision forms, terminate the negotiations on new wage levels, new prices and new rents, carry on their boycotts and complete any other possible actions. All water related decisions by the private and public decision-makers are completed. Treatment plants are built, industries shut down, fine levied, sampling stations constructed, etc.

When the round ends, participants campaign and carry out new elections, hold town meetings, debrief their actions, and develop new strategies while the computer performs its functions and prepares new output on the status of the simulated city.

F. The Function of the Computer

In the model, players are able to exercise a number of decision alternatives. Only some of these will be communicated to the computer, the rest will be part of the constant communication, bargaining and negotiating carried out in the game-room itself.

The computer performs several major functions in the model.

First, it stores all the relevant economic, social and governmental statistics for the area; updates data when changes are made; and prints out yearly reports on the status of the local system and reports for the economic, social, and government decision-makers.

Second, the computer simulates the actions of the outside system. For example, the computer simulates both a national business cycle, the probabilities of federal-state aid and interest rates on most loans.

Third, the computer performs certain routine functions or processes that would be time-consuming if the players themselves were to perform them. For example, the computer assigns workers from population units to jobs under the assumption that workers will attempt to earn as much money as possible. Other processes include assessing all property, assigning buyers of goods and services to shop at particular commercial establishments, assigning children to public or private schools based upon the capacity and quality of the public schools, and assigning population units to residences based on their desirability. The computer also simulates the migration process which moves population units into, out of, and within the local system. It also measures all of the types of pollution at all points along the river system and calculates a comprehensive water quality index.

II. THE GOVERNMENT SECTOR

A. Introduction to the Sector

The GOVERNMENT SECTOR represents the management apparatus for the public sector of the area represented by the model. Participants in this Sector are the elected and appointed public officials. The Government Sector can make public policy, implement plans and programs, provide public services and raise and disperse funds. The model is sufficiently flexible that the Government Sector can be operated using strong central control or somewhat autonomous departments as determined by the participants. There is a separate government apparatus for each of the political jurisdictions represented by the model. Thus, intergovernmental cooperation and competition may evolve during the play.

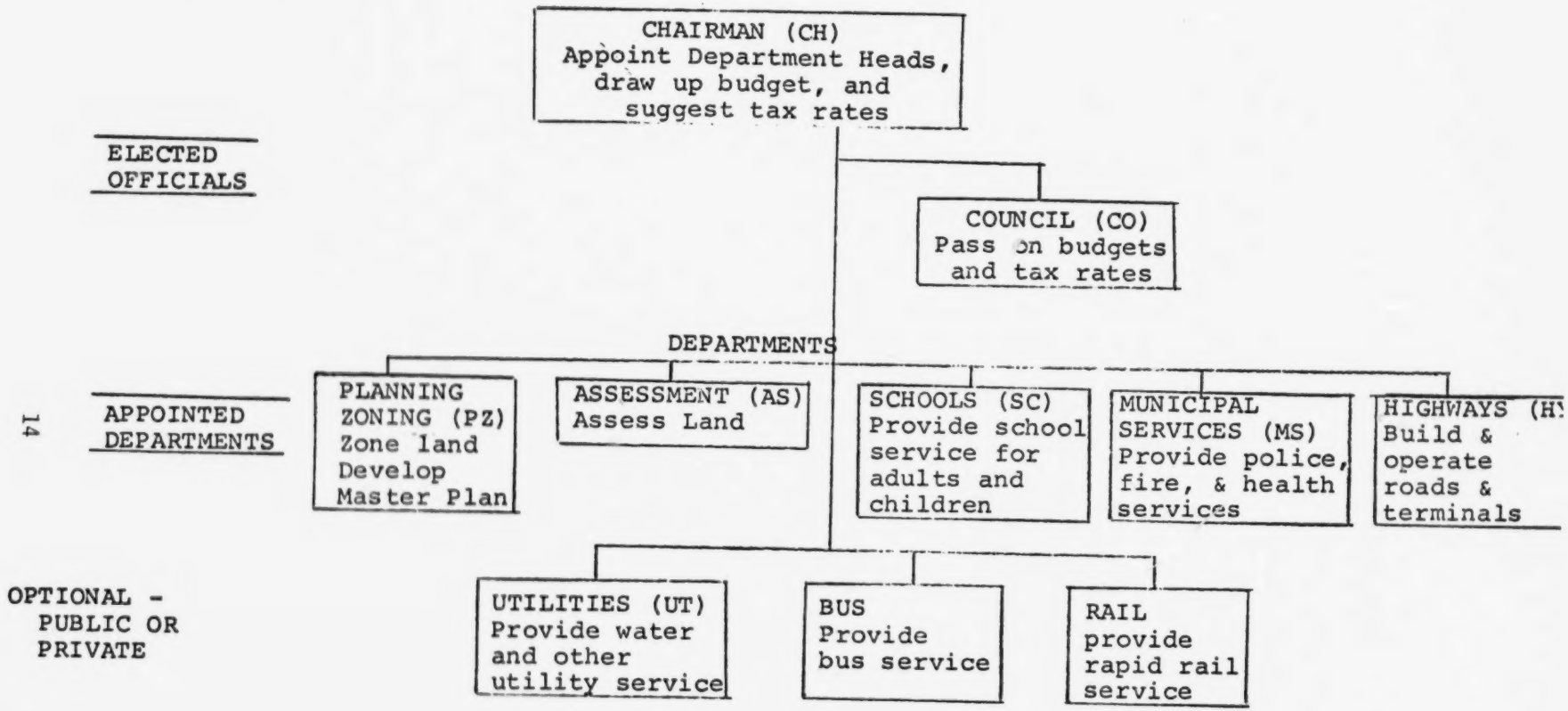
B. Sector Functions

Figure GV1 shows the government structure that may exist in each of the local systems. The Bus and Rail Departments are systemwide functions, whereas the other departments operate on a jurisdiction basis. As noted, the Chairman (or Mayor) and Council are elected in each of the jurisdictions, and the department (staff) decision-makers are appointed by the chairman. The optional public departments, Utilities, Bus and Rail are usually part of the Government Sector, as quasi public functions, but they can also be operated as private (economic) sector activities either initially or as a result of participant action (public sale). The codes used to identify the government functions are shown in parentheses after the function name in Figure GV-1.

Elected officials are accountable to the electorate (the social sector). They are required to respond to public hearings, propose and defend referenda on certain issues, and stand for election. The manner in which elected officials exercise power and conduct their administration and public affairs, however, is at their discretion.

Appointed Department representatives are responsible to the Chairman and Council. However, the presence or absence of effective leadership and communication may influence this relationship and staff decisions. The Government Sector decision-makers depend for their political life on the votes of the social sector. Their relationship with the business community is determined by their own view of public office and public service.

GOVERNMENT STRUCTURE



C. Administrative (Non-Decision) Functions

Any number of additional administrative functions can be created to approximate local structures or to examine a variety of administrative mechanisms. While these optional functions do not make direct input decisions to the computer, they may be created to have as much advisory, regulatory or "legal" influence as the participants (or Director) determine. An ENVIRONMENTAL QUALITY CONTROL Commission, for instance, could be established to act as a regulatory agency in the area of water quality and as such could influence current economic activities and future development.

D. Government Decisions

The Government Sector decisions cover a wide spectrum of municipal and public service activities. The types of possible decisions are listed in Figure GV-2, with an indication of the individual decision-makers with primary interest or responsibility. Complete descriptions are in each decision-maker's manual.

In the model, as in the real world, the government can anticipate the emergence of pressing issues related to jobs, housing, economic development, education, public transit, and the environmental quality of their region.

This issue may, for example, occur in the form of special zoning requests, substantial school budgets for adult education, or adamant citizen demands for clean water, increased recreation facilities or lower utility rates.

E. Government Output

It rarely happens that the government has all the information it wants, or needs, to make perfect decisions. Many decisions, under pressures of time, will be typical "guesstimates" - intuitive actions. It is possible, however, for each activity to develop an effective information system using the available resources in the model.

For the local system, the general output is usually posted each round and is available to all decision-makers for general information and analysis. The general output makes available to each participant, in maps, detail and summary form, extensive current and comparative information about conditions, trends and characteristics of the region. The range of information in the maps and the items of General Output cannot be overemphasized. Experience

GV-2

GOVERNMENT SECTOR DECISIONS

TYPE OF DECISION	PRIMARY INTEREST								
	CH CO	AS	SC	MS	HY	PZ	UT	BU	RA
Grant Appropriations	x								
Grant Subsidies	x								
Transfer Cash	x		x	x	x	x	x	x	x
Set Welfare Payments	x								
Set Tax Rates	x								
Float Bonds	x								
Assess Land, Buildings		x							
Buy and Sell Land			x	x	x	x	x		x
Establish Government Jobs			x	x				x	x
Establish Maintenance Levels of Government Facilities			x	x	x			x	x
Establish Service Districts			x	x			x		
Request Federal State Aid	x		x		x				
Establish Employee Salaries			x	x				x	x
Build and Demolish Schools			x						
Establish Adult Education Programs			x						
Build and Demolish Municipal Service Plants				x					
Contract to Purchase Goods and Services			x	x					
Construct and Demolish Roads					x				
Construct and Demolish Terminals					x				
Zone Land						x			
Create and Demolish Public Institutional Land Uses						x			

GV-2 (Cont.)

GOVERNMENT SECTOR DECISIONS

TYPE OF DECISION	PRIMARY INTEREST								
	CH CO	AS	SC	MS	HY	PZ	UT	BU	RA
Provide Parkland						x			
Install Utility Services							x		
Set Utility Service Prices							x		
Construct and Demolish Utility Plants							x		
Locate Public Transit Routes								x	x
Buy and Sell Rolling Stock								x	x
Set Fares								x	x
Establish Amount of Transit Service								x	x
Construct Rail Lines and Stations									x
Set Water Prices							x		
Construct Treatment Plants (intake and outflow)							x		
Specify Intake and Outflow Points							x		
Establish Water Sampling Stations									
Set Dam Priorities	x						x		

with the model has indicated that decisions are facilitated if the participants use the General Output information as part of their decision process.

The complete government sector output consists of the information, maps and detail made available to each government decision-making function of the government. Each government function has available to it a comprehensive portrayal of its status and the conditions which pertain to its activities.

F. Government Budgetary Procedures

The same general financial accounting procedure is used for all government departments, including Utilities, Bus and Rail. Department budgets are divided into Capital and Current accounts. Departments may transfer funds from one account to another, but no automatic transfers will take place. Appropriations, subsidies, and cash transfers to departments must be directed to either the capital or current account.

The Chairman's account has only a current account, the Planning and Zoning Department has only a capital account, and the Assessment Department has no financial accounts. All other departments have both accounts.

The Chairman makes appropriations, and subsidies from his current account before he actually receives income to his account. His is the only department which makes expenditures before income is calculated. Once a department has received an appropriation, the money is never automatically transferred back to the Chairman's account. If the Chairman spends more than he later receives in revenue, a current bond is automatically floated in the Chairman's name and is paid off from the Chairman's account. If a department spends more than its revenues (this can only happen in a department's current account), a current bond is floated in the department's name and is paid off from the department's account.

The following format is contained within each account:

Previous Cash Balance
Revenues
Expenditures
New Cash Balance.

If the output is for round T, then Previous Cash Balance would be equal to the New Cash Balance for round T-1.

Expenditures may not be made from capital accounts unless there is sufficient cash to cover the expenditure. Therefore, the cash balance in a capital account is always greater than or equal to zero; the cash balance in the capital account may not be negative.

If expenditures from the current account are greater than previous balance plus revenues, then a short term bond (current or two-year) is automatically floated to cover the deficit. Therefore, the New Cash Balance may never be negative in the current account. Because of rounding, the New Cash Balance will normally be slightly positive (rather than zero) even in the case where a short-term bond had to be floated.

All capital expenditures are player or director decisions which have been submitted during the previous EDIT. Current expenditures are made according to government policies which may have been established in any previous EDIT. Current expenditures (except miscellaneous expenditures) do not directly reflect player decisions; they are functions of policies. For example, a player sets the salaries and number of job openings which the School Department offers, but other local conditions influence how many employees the department actually hires and thus influence the amount which the department pays in salaries.

The most common capital revenue sources for departments are appropriations (for MS, SC, HY, and PZ), capital bonding for 25 years (all departments), Federal-State Aid (SC, HY) and miscellaneous sources (sale of land, and incoming cash transfers). Special capital revenue sources are subsidies to the Utility Department.

The most common capital expenditures are for construction, land purchase, and miscellaneous (outgoing cash transfers).

The most common current revenue sources are appropriations (all but UT and CH), short term bonding, Federal-State Aid (MS and SC), and miscellaneous income (incoming cash transfers).

Special current revenue sources exist for the Utility Department (income from user charges on utility and water service and subsidies) and the Chairman (taxes).

The most common current expenditures are for bond payments (capital bonds and current bonds together), goods and services (MS, SC, maintenance for HY, and utility operating costs for UT), salaries (MS and SC), and miscellaneous (outgoing cash transfers).

Special current expenditures are for welfare payments (MS), adult education (SC), treatment operating costs and sampling station operating costs (UT), and subsidies (CH).

G. GOVERNMENT MASTER TABLE
(Characteristics are for Level One Development)

	SC	MS	UT	HY	TM	RAIL STATION	RAIL TRACKS (Per Mi) SURFACE	RAIL TRACKS (Per Mi) UNDER-GROUND	VEHICLES RAIL	VEHICLES BUS
CONSTRUCTION COST (Millions of Dollars)	27	30	30	.8M	14	1	4	NA	.8/mi	.4/mi
DEMOLITION COST (Millions of Dollars)	5.4	6	6	.16M	2.8M	NA	NA	NA		
CHARACTERISTICS OF FACILITIES										
Possible Levels of Development	3	3	3	3	3	1	1	1		
Land Requirement (% of a parcel)	16	12	20	8	12	NONE	4	NONE		
Rate of Annual Depreciation (%)	2.0	3.3	NA	5.0	NA	NA	NA	NA	3.5	3.5

	SC	MS	UT	HY	RAIL	BUS	PZ
POSSIBLE SOURCES OF REVENUE TO DEPARTMENTS							
Current Funds							
Appropriations	x	x		x			
Subsidy			x		x	x	
Cash Transfer	x	x	x	x	x	x	
Automatic Bonding	x	x	x	x	x	x	
Automatic Federal State Aid	x	x					
Capital Funds							
Appropriations	x	x		x			x
Subsidy			x		x	x	
Cash Transfer	x	x	x	x	x	x	x
Bonding	x	x	x	x	x	x	x
Federal-State Aid	x			x			
Charges to Users			x		x	x	
Labor Hired	PH PM	PM PL	NA	NA	PM	PM	NA

III. HIGHWAY DEPARTMENT

A. Introduction

This manual contains the basic information and description of the model required by the Highway Department. It is assumed that the Model Overview, the Scenario, and the Government Sector descriptions have been read prior to the receipt of this manual.

Once the players comprising the Highway Department have become familiar with the model in general, the particular city being represented, and the workings of the local transportation subsystem they will be able to bring their own imagination and initiative to bear on the operation of the Highway Department in their specific jurisdiction.

The local Highway Department has influence over the transportation accessibilities within the local dynamic system and it will have the opportunity to alter these accessibilities in such a way as to satisfy self-established goals and/or to respond to pressures brought on it by elected officials and the local citizenry and business community.

B. Highway Department Summary

The Highway Department has the responsibility for two types of transportation decision-making: building and maintaining the highway system within the jurisdiction and building transportation terminals to be used by local businesses as places to ship and receive finished products to and from national markets.

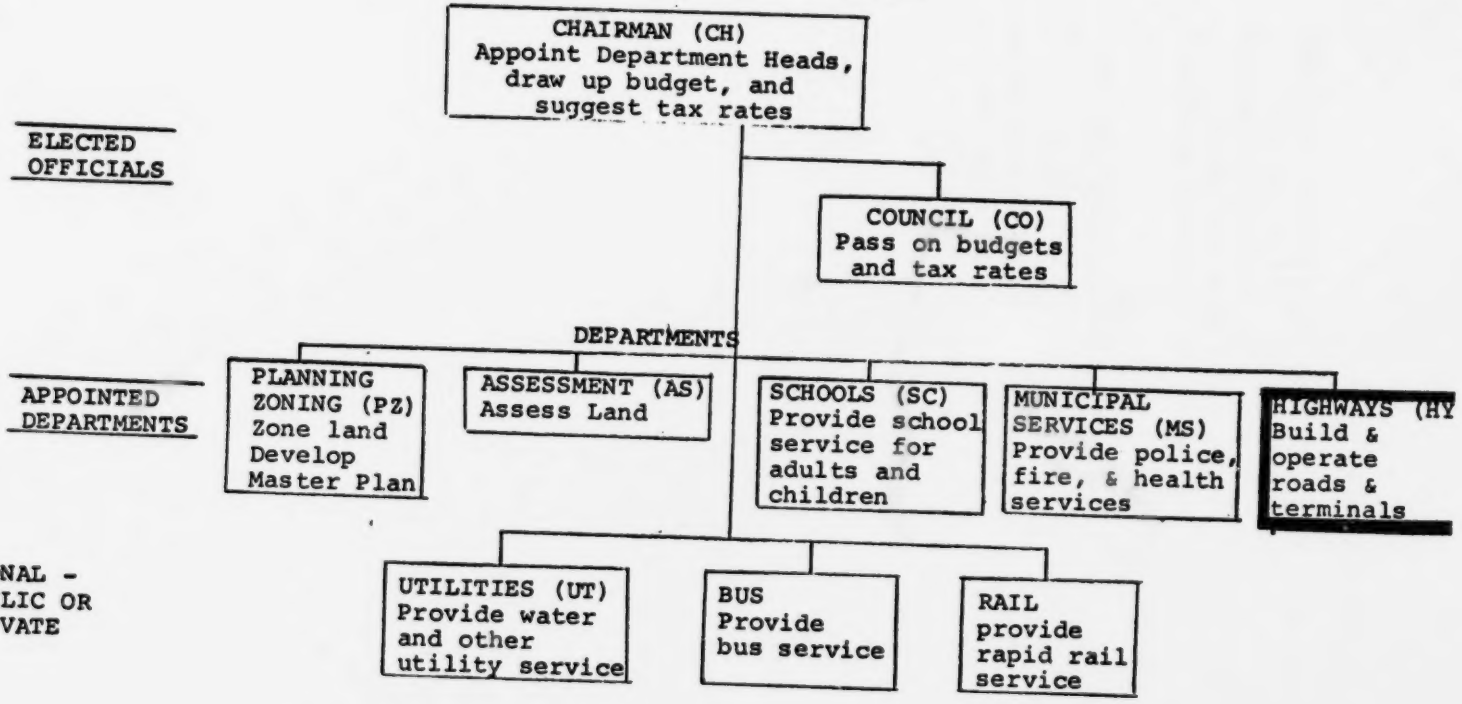
The local highway system is used by all auto and bus peak-hour to work commuters and by all persons and businesses for their local commercial activities. Roads of several capacity categories may be constructed. These roads become congested at peak hours when more vehicles use them than they were designed to handle. Congestion raises the time and dollar costs of population units travelling over the congested roads.

Terminals are located at intersections of roads, and they may be of several capacity levels. Both terminals and roads require land from the parcels they abut.

Figure HY-1 shows the Highway Department as it fits within the local government structure.

Figure HY-1

THE HIGHWAYS DEPARTMENT AS IT FITS
WITHIN THE LOCAL GOVERNMENT STRUCTURE



IV. COMPUTER PRINTED OUTPUT DESCRIPTION

A. Introduction

The printed computer output provides a yearly report of the status of the simulated region and of interactions within the region during the previous year. There are several types of output: maps showing characteristics of the region which differ geographically; summaries which present information in capsulated form; and detailed information from which the summaries are derived.

The figure on the next page shows the titles of the output sections in the order in which they are printed. That sequence follows neither the logical order of computer program operations nor the usual sequence in which a user examines the output. The code number beside the title of each section of output listed in this figure is the code number used in all examples of output included in this manual. The output is explained in this section in order of most general to most detailed information. Output is explained in the following order:

- maps
- summary information
- general information of relevance to all three sectors
- social sector detail
- economic sector detail
- government sector detail

There are a few standard features of all printed output sections. Each has a title which is a short description of the type of information given by the section of output. Each also contains both the round number and the game heading (the name of the data base being used or some other heading input by the director). Where relevant, a jurisdiction number is also printed.

After a few rounds' experience with the model, a model user usually needs only the printed computer output from a round and the Master Tables and input formats contained in this manual in order to play subsequent rounds.

RIVER BASIN MODEL OUTPUT

1. Migration
   - 1.1 Environmental Indexes
   - 1.2 Personal Indexes
   - 1.3 Dissatisfaction Cutoffs
   - 1.4 Migration Detail
   - 1.5 Migration Statistics
   - 1.6 Migration Summary

2. Water System
   - 2.1 Water User Effluent Content
   - 2.2 River Quality During Surface Water Process
   - 2.3 Water User Costs and Consumption
   - 2.4 Coliform and Pollution Index Values

3. Employment
   - 3.1 Employment Selection Information for PL Class
   - 3.2 Employment Selection Information for PM Class
   - 3.3 Employment Selection Information for PH Class
   - 3.4 Part-Time Work Allocation for PH Class
   - 3.5 Part-Time Work Allocation for PM Class
   - 3.6 Part-Time Work Allocation for PL Class
   - 3.7 Employment Summary

4. Commercial Allocation
   - 4.1 Personal Goods Allocation Summary
   - 4.2 Personal Services Allocation Summary
   - 4.3 Business Goods Allocation Summary
   - 4.4 Business Services Allocation Summary
   - 4.5 Government Contracts
   - 4.6 Terminal Demand and Supply Table
   - 4.7 Terminal Allocation Map

5. Social Sector
   - 5.1 Dollar Value of Time
   - 5.2 Social Decision-Maker Output
   - 5.3 Social Boycotts

6. Economic Sector
   - 6.1 Farm Output
   - 6.2 Residence Output
   - 6.3 Basic Industry Output
   - 6.4 Commercial Output
   - 6.5 Economic Boycott Status
   - 6.6 New Construction Table
   - 6.7 Land Summary
   - 6.8 Loan Statement
   - 6.9 Financial Summary

7. Social and Economic Summaries
   - 7.1 Number of Levels of Economic Activity Controlled by Teams
   - 7.2 Employment Centers
   - 7.3 Economic Control Summary for Teams
   - 7.4 Social Control Summary for Teams
   - 7.5 Social Control Summary Totals
   - 7.6 Economic Graphs for Teams
   - 7.7 Social Graphs for Teams

8. Government Detail
   - 8.1 Assessment Report
   - 8.2 Water Department Reports
   - 8.3 Sampling Station Reports: Point Source Quality
   - 8.4 Sampling Station Reports: Ambient Quality
   - 8.5 Utility Department Report
   - 8.6 Utility Department Finances
   - 8.7 Municipal Services Department Report
   - 8.8 Municipal Services Department Finances
   - 8.9 Municipal Services Department Construction Table
   - 8.10 Planning and Zoning Department Report
   - 8.11 School Department Report
   - 8.12 School Department Finances
   - 8.13 School Department Construction Table
   - 8.14 Highway Department Finances
   - 8.15 Highway Department Construction Table
   - 8.16 Rail Company Report
   - 8.17 Bus Company Report
   - 8.18 Chairman Department Finances
   - 8.19 Tax Summary
   - 8.20 Financial Summary

9. Summary Statistics
   - 9.1 Demographic and Economic Statistics

10. Maps
    - 10.1 Personal Goods Allocation Map
    - 10.2 Personal Services Allocation Map
    - 10.3 Business Commercial Allocation Map
    - 10.4 Municipal Service Map
    - 10.5 School Map
    - 10.6 Utility Map
    - 10.7 Water Usage Map
    - 10.8 Water Quality Map
    - 10.9 Municipal Treatment
    - 10.10 Municipal Intake and Outflow Point Map
    - 10.11 Surface Water Map
    - 10.12 Farm Runoff Map
    - 10.13 River Basin Flood Plain Map
    - 10.14 Farm Map
    - 10.15 Farm Assessed and Market Value Map
    - 10.16 Market Value Map
    - 10.17 Assessed Value Map
    - 10.18 Economic Status Map
    - 10.19 Highway Map
    - 10.20 Planning and Zoning Map
    - 10.21 Parkland Usage Map
    - 10.22 Socio-Economic Distribution Map
    - 10.23 Demographic Map
    - 10.24 Social Decision-Maker Map
    - 10.25 Topographical Restriction Map
    - 10.26 Government Status Map

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B. Map Output

The model output includes several maps which visually represent characteristics of the simulated region which differ by location. The entire simulated region is represented on a single, two-page computer map. A map key is printed at the bottom of each page. Map symbols appear on a map in the three types of locations which can be specified in the model: parcels (squares), parcel edges (lines separating squares), and intersections of lines (parcel corners). Land uses and other characteristics of parcels are represented within the squares. Divisions between parcels such as roads or jurisdiction boundaries are represented between parcels, and activities such as terminals are represented at parcel corners.

The Map Titles and a brief description of their contents are given below, in the order in which they will be discussed. All information is located spatially.

Economic Status Map: economic owners, economic activities and operating levels, zoning, levels of utilities installed, amounts of undeveloped land, road types, terminal levels, jurisdiction boundaries.

Government Status Map: school levels, parks, municipal service levels, utility plant levels, road types, terminal levels, jurisdiction boundaries.

Socio-Economic Distribution Map: residence types and levels, number of Pl's of each class, road types, terminal levels, jurisdiction boundaries.

Demographic Map: populations, residential quality indexes, business value ratios, percent occupancy, road types, terminal levels, jurisdiction boundaries.

Personal Goods Allocation Map: PG shopping location for each class and residence, PG location.

Personal Services Allocation Map: PS shopping location for each class and residence, PS location.

Business Commercial Map: BG and BS shopping location for each business, BG and BS locations.

Utility Map: utility units served, utility units installed, utility plants, utility district boundaries, jurisdiction boundaries.

Surface Water Map: volumes of surface water, rates of flow, land area in water, directions of surface water flow, lakes.

Municipal Treatment Plant Map: municipal water intake treatment plants and levels, municipal sewage treatment plant types and levels, utility plant locations and code numbers, directions of surface water flow, utility district boundaries, lakes.

Municipal Inflow and Outflow Point Map: Municipal surface water intake points, municipal sewage outflow points, utility districts served by each, surface water qualities, directions of surface water flow, utility district boundaries, lakes.

Water Quality Map: economic activities and operating levels, surface water qualities, directions of surface water flow, lakes.

Economic Sector Water Usage Map: economic activities and operating levels, amounts of recycling, business effluent treatment types and levels, utility district boundaries, jurisdiction boundaries.

Municipal Services Map: economic activities and operating levels, municipal service units required, municipal services and their use indexes, municipal service district boundaries, jurisdiction boundaries.

School Map: numbers of public school students, numbers of private school students, schools and their use indexes, school district boundaries, jurisdiction boundaries.

Highway Map: economic activities and operating levels, road types, terminal levels.

Planning and Zoning Map: zoning, park, public institutional land uses, road types, terminal levels, jurisdiction boundaries.

Parkland Usage Map: parks, populations served by park, park use indexes, road types, terminal levels, jurisdiction boundaries.

Market Value Map: market values of all non-farm land, privately owned buildings, and privately owned land and buildings, road types, terminal levels, jurisdiction boundaries.

Assessed Value Map: assessed values of non-farm privately owned land and buildings, road types, terminal levels, jurisdiction boundaries.

Farm Assessed and Market Value Map: assessed and market values of farms, amount of land in farms, road types, terminal levels, jurisdiction boundaries, lakes.

Farm Map: farm owners, amount of land in farms, farm types, levels of fertilization, road types, terminal levels, jurisdiction boundaries.

Farm Runoff Map: where runoff from farms flows, direction of surface water flow, lakes.

River Basin Flood Plain Map: river basins, dam priorities, flood susceptibility of each parcel, direction of surface water flow, lakes, jurisdiction boundaries.

Topographical Restriction Map: topographically undevelopable land, road types, terminal levels, jurisdiction boundaries.

Social Decision-Maker Map: social decision-maker controlling each class living on each residence parcel, road types, terminal levels, jurisdiction boundaries.

1. Economic Status Map

This map shows the economic sector owners of all privately-owned non-farm parcels and the economic activity, if any, on each parcel. A parcel can have only one economic owner and one economic activity. Owners of farm parcels are shown on the Farm Map. The types of economic activities represented in the model are listed in the Master Tables.

The economic owner of a parcel owns all of the land and developments on the parcel which do not belong to the government or which are not topographically undevelopable. If the economic owner sells land to another economic decision-maker, he must sell all of the privately-owned land and buildings on the parcel to the new owner. An economic decision-maker can sell any portion of undeveloped land on a parcel to a government department.

The Planning and Zoning Department may zone parcels. Zoning is a restriction on economic development. Once a parcel is assigned a particular zoning code, all new economic development on the parcel must conform to the new zoning. If a parcel is unzoned, there is no restriction on what type of activity may be constructed on it. The Economic Status Map key defines what private land uses are allowed under each zoning code.

When a new economic development is constructed on a parcel, it must not only conform to the parcel's zoning; it must have sufficient utility service. Utilities are installed by the Utility Department in "levels" (1 - 9). Each level of economic activity requires a certain number of utility units, and each level of utility service supplies a fixed number of utility units to a parcel.

If an economic decision-maker has insufficient utility service for a proposed development, the Utility Department must install adequate utility service before the new development can be constructed.*

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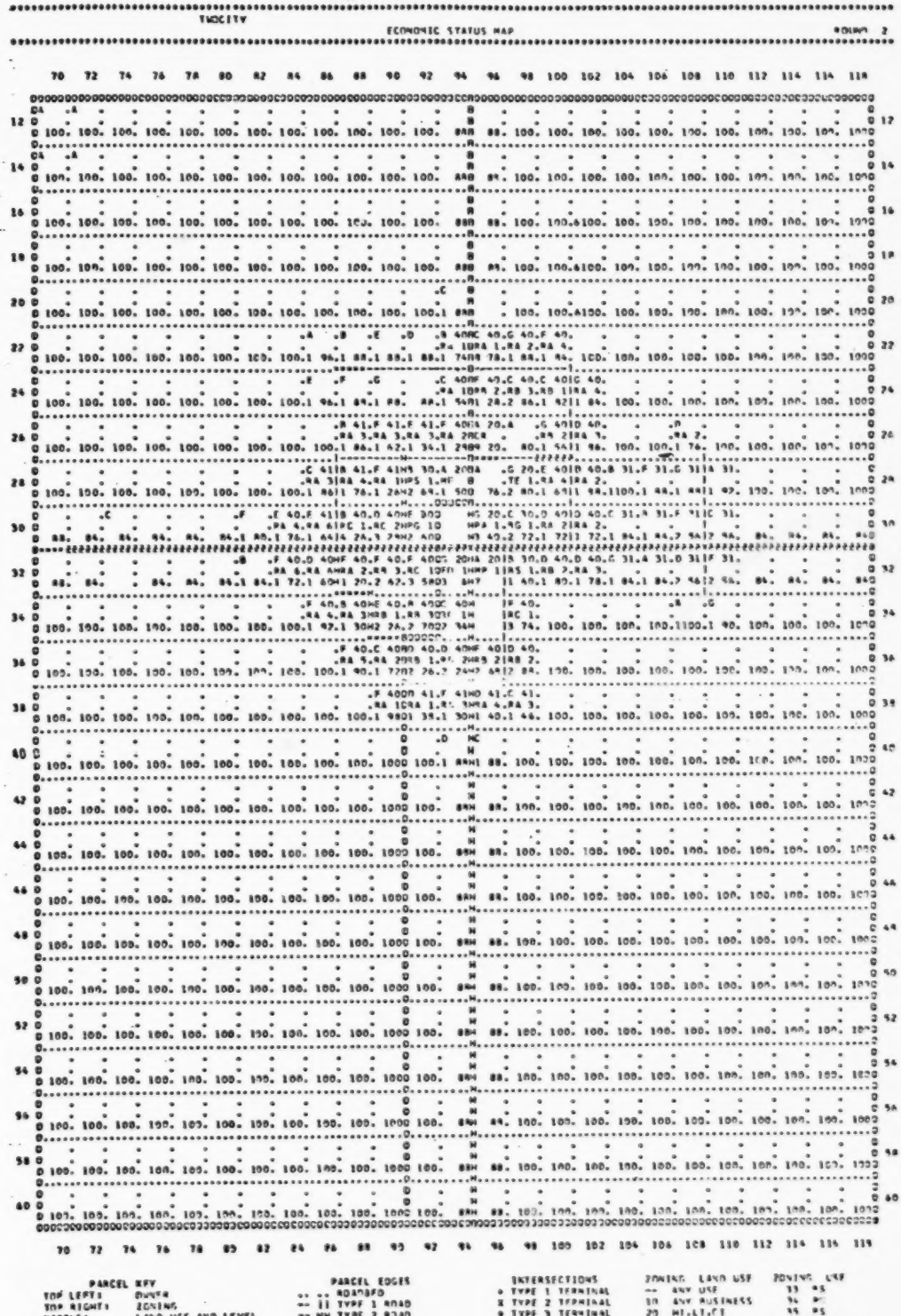
*There are two exceptions to the utility restriction on development: 1) RA housing can be built with "private utilities", which do not require utilities supplied by the Utility Department: 2) the director can override the utility restriction on individual developments.

Figure 10.18


TYCITY
ECONOMIC STATUS MAP
PARCEL KEY
TOP LEFT: OWNER
TOP RIGHT: ZONING
MIDDLE: LAND USE AND LEVEL
BOTTOM LEFT: UTILITY LEVEL
BOTTOM RIGHT: % UNDEVLPD LAND
PARCEL EDGES
== == ROADBED
== II TYPE 1 ROAD
== HH TYPE 2 ROAD
TYPE 3 ROAD
CO OO JURISDICTION BOUNDARY
INTERSECTIONS
O TYPE 1 TERMINAL
X TYPE 2 TERMINAL
O TYPE 3 TERMINAL
ZONING LAND USE
-- ANY USE
10 ANY BUSINESS
20 MI,LI,CI
21 MI
22 LI
23 CI
30 MX,MC,MS,PC,PS
31 MS
32 MC
ZONING USE
33 MS
34 PC
35 PS
40 PA,IR,PC
41 RA
42 RM
43 RC
50 PARKLAND

Economic developments also require land. Each activity, depending on its type, requires a certain amount of land for each constructed level of development. Regardless of the operating level of an activity, the land consumed is that of the constructed level, which is always greater than or equal to the operating level. The amount of privately-owned land which is not in developments is classified on this map as undeveloped. If a parcel shows no undeveloped land, no further economic development can occur there unless the owner either acquires more land from a government department owning a portion of the parcel or demolishes existing economic developments. An economic decision-maker can acquire land by purchasing a parcel from another economic decision-maker or by bidding on land which is owned by the Outside.

The operating level of an economic activity is shown on the Economic Status Map. For most purposes, a business' operating level is the only level considered by the computer programs. However, a business pays property taxes and maintenance for its constructed level.

2. Government Status Map

Whereas there can be only one economic owner per parcel, any combination of government departments can own developed and undeveloped land on a parcel. The government departments which can own land, and the types of developments each can construct on a parcel are:

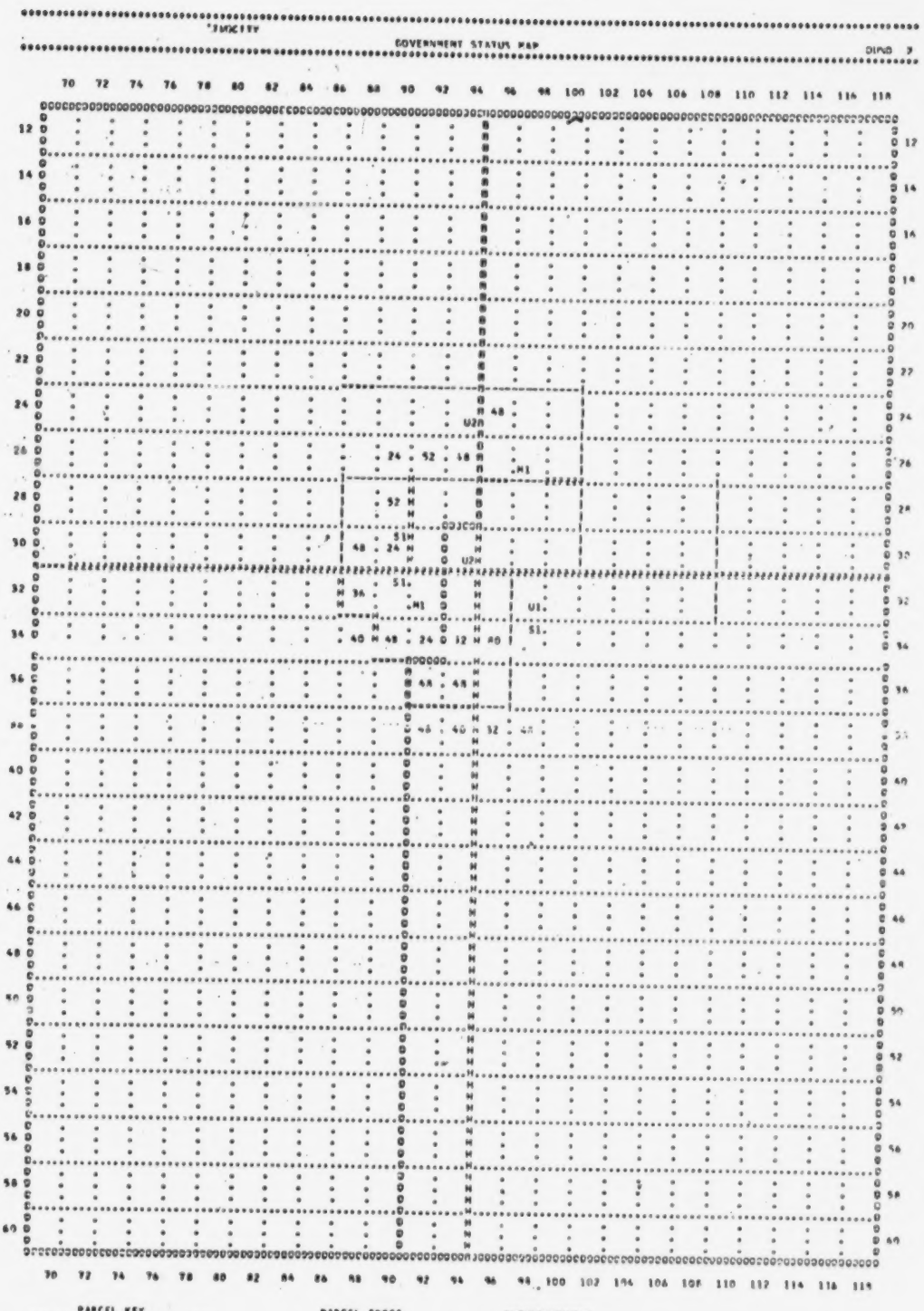
Department	Development Type
Utility Department	Utility Plant Water Intake Treatment Plant Sewage Outflow Treatment Plant: Chlorination Primary Treatment Secondary Treatment Tertiary Treatment
School Department	School Unit
Municipal Service Department	Municipal Service Unit
Planning and Zoning Department	Parkland Public Institutional Land
Highway Department	Road* Terminal*

A government department can sell undeveloped land which it owns to either another government department or to the economic decision-maker owning the privately-owned portion of a parcel.

The government status map shows the locations of some of the types of government activities: schools, parks, utility plants, and municipal service units.

*A road requires land from the parcels on each side, and a terminal requires land from the four parcels touching the intersection at which it is located.

Figure 10.26


GOVERNMENT STATUS MAP
PARCEL KEY
TOP RIGHT: SCHOOL + LEVEL
MIDDLE ROW: S UNOV PARLND
BOTTOM LEFT: MS UNIT + LEVEL
BOTTOM RIGHT: UT PLANT + LVL
PARCEL EDGES
** ** ROADBED
-- II TYPE 1 ROAD
== HH TYPE 2 ROAD
HH TYPE 3 ROAD
@@ @@ JURISDICTION BOUNDARY
INTERSECTIONS
+ TYPE 1 TERMINAL
X TYPE 2 TERMINAL
* TYPE 3 TERMINAL

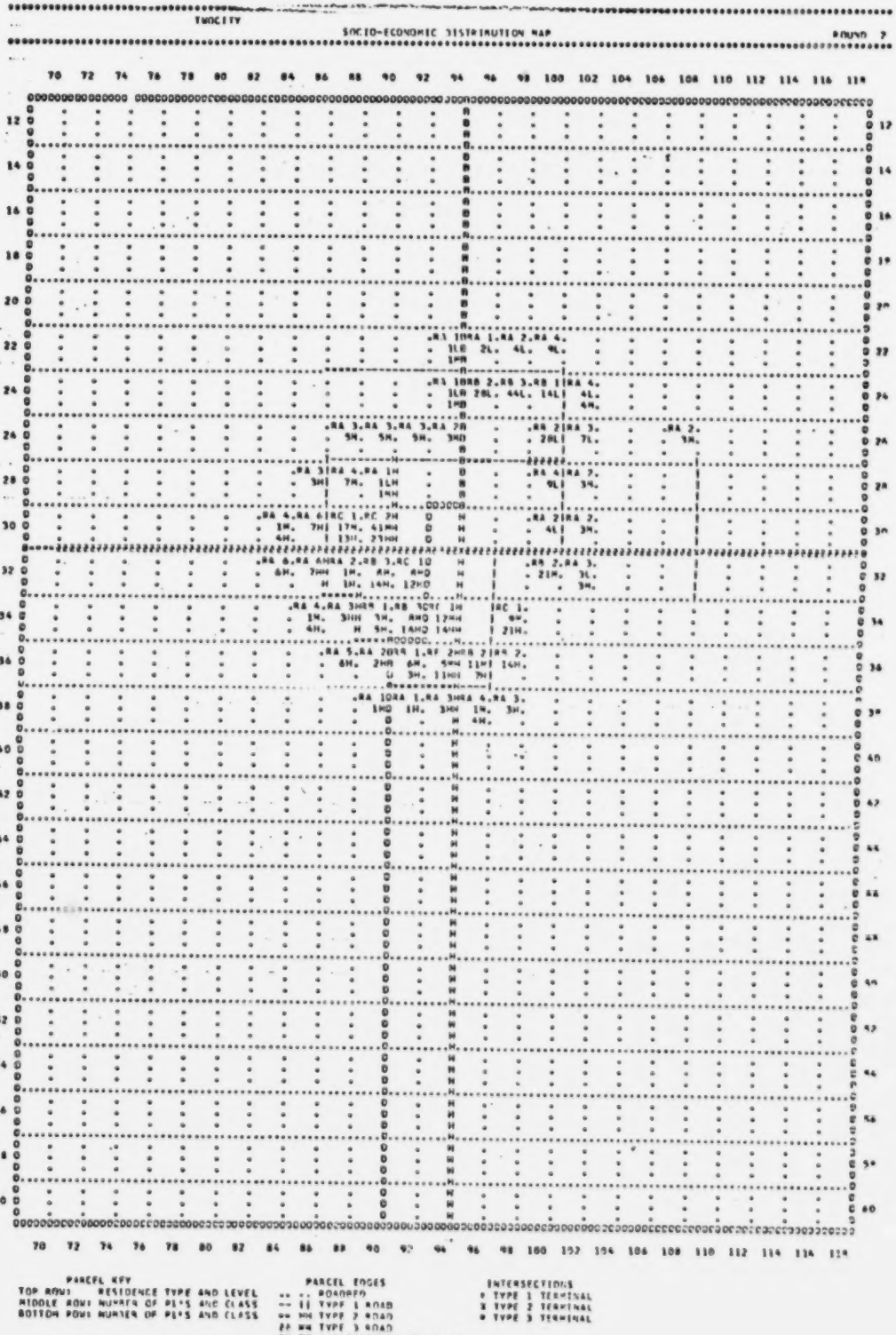
3. Socio-Economic Distribution Map

This map shows the number of P1's of each class living on each residence parcel. The residence type and level are also printed.

The migration process allocates people to housing. Only two classes can live on a residence parcel simultaneously, due in part to the model's restriction that a PH will not move into a residence with a quality index below 71 and a PL will not move into housing with a quality index above 70. It is possible, if a residence depreciates below the minimum that a class will accept, that high-income, for example, will live in a residence with a quality index below 71 if the class was living on the parcel before the depreciation. In no case, however, can PH's reside on the same parcel with PL's.

Each level of a residence type provides a fixed number of space units. A P1 occupies a fixed number of space units, depending on its class. The percent occupancy of each residence is shown on the Demographic Map.

Figure 10.22


TWOCITY
SOCIO-ECONOMIC DISTRIBUTION MAP
ROUND 2
PARCEL KEY
TOP ROW: RESIDENCE TYPE AND LEVEL
MIDDLE ROW: NUMBER OF PE'S AND CLASS
BOTTOM ROW: NUMBER OF PE'S AND CLASS
PARCEL EDGES
-- -- ROADBED
-- II TYPE 1 ROAD
== == TYPE 2 ROAD
TYPE 3 ROAD
@@ @@ JURISDICTION BOUNDARY
INTERSECTIONS
+ TYPE 1 TERMINAL
X TYPE 2 TERMINAL
* TYPE 3 TERMINAL

4. Demographic Map

The demographic map shows the number of people living on each residence parcel, the percent occupancy of each residence and the quality of all privately owned buildings and equipment.

Overcrowding (over 100% occupancy) contributes to a residence's neighborhood index and to the health index.

The quality is expressed as the quality index for a residence and as the value ratio for non-residential activities. A value ratio is the ratio of the present condition of a business' buildings and equipment to their original condition, expressed as a percent.

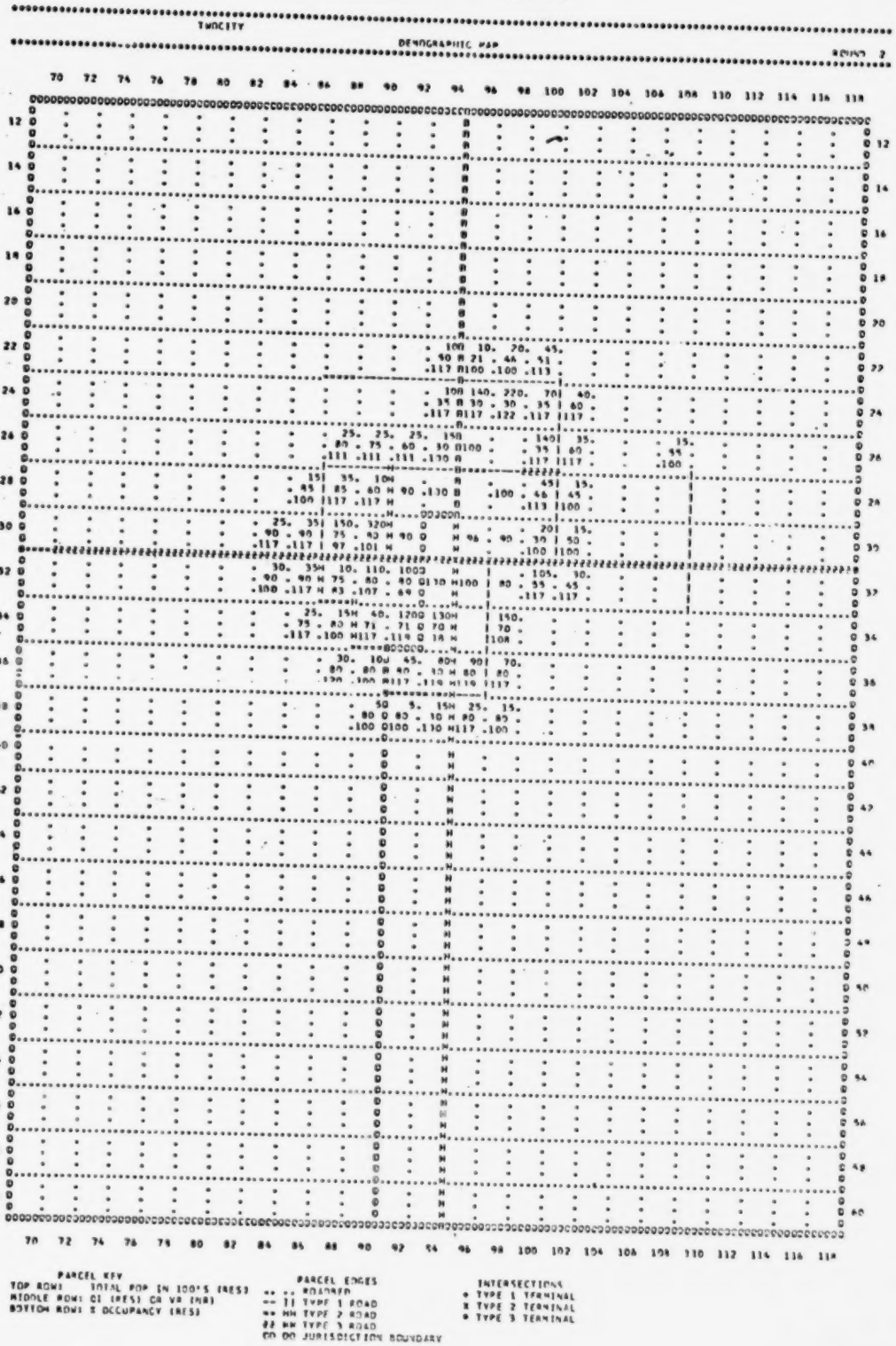
A quality index is somewhat different. Whereas a new business has a value ratio of 100, a new residence can have a quality index from 40 to 100.

Each year buildings and equipment depreciate in response to several conditions which vary by type of activity (see the Master Tables for the causes of depreciation). A business's depreciation is measured as a percent of original value (100). A residence's depreciation is measured as a percent of the original value of such a type of residence originally built at a quality index of 100, regardless of the original quality of the specific residence. Thus, business depreciation is a percent of original value but residential depreciation is a percent of quality index 100.

The owner of an activity can set a maintenance level for the activity. The maintenance level is the quality index or value ratio at which the owner will maintain the activity, regardless of how much it depreciates in a year. Not until the activity's value ratio or quality index falls to its maintenance level does the owner incur maintenance expenditures. The computer program depreciates and maintains buildings and equipment and charges the owner for the maintenance cost.

The Demographic Map shows quality indexes and value ratios after depreciation and after any maintenance.

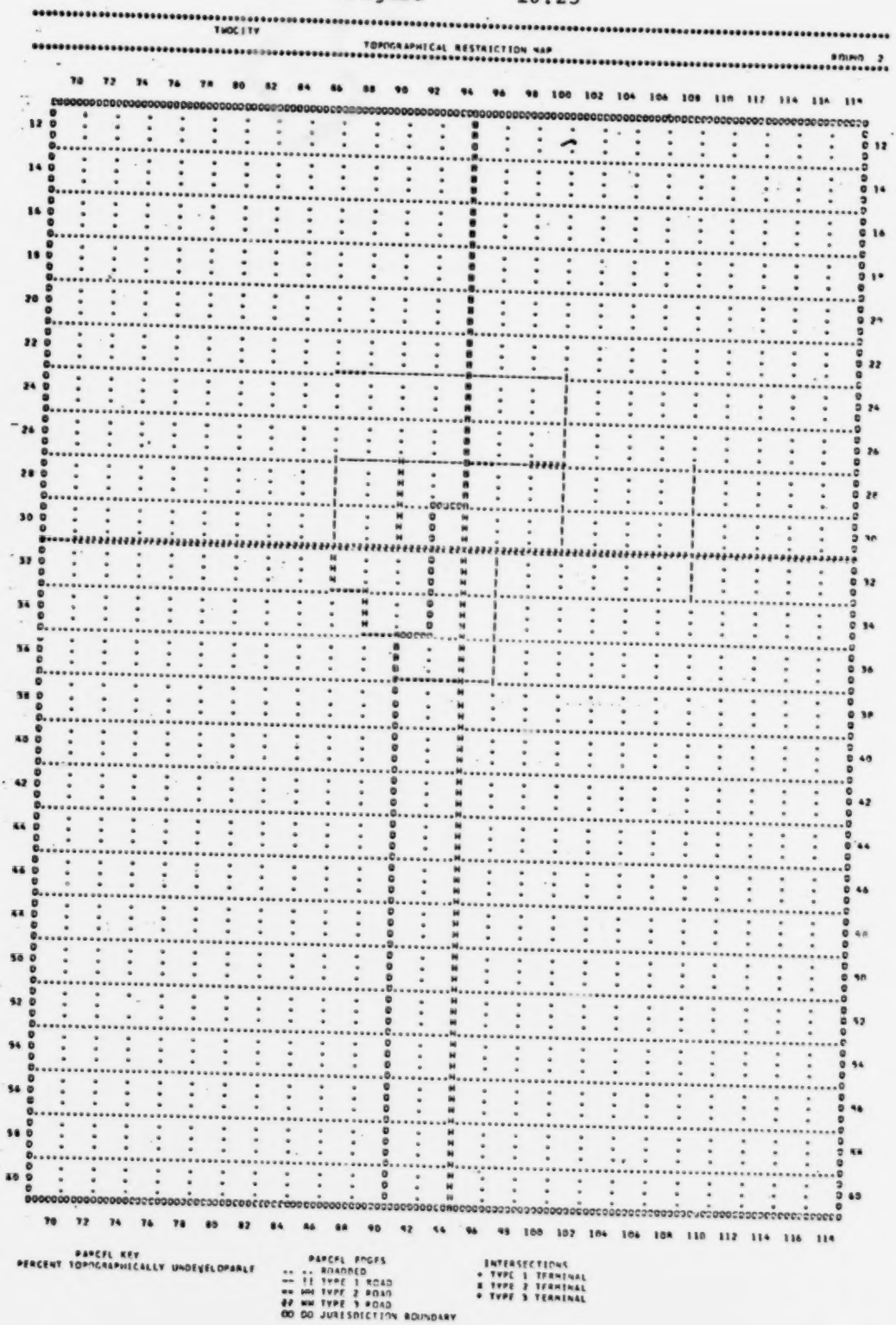
Figure 10.23


TWOCITY
DEMOGRAPHIC MAP
PARCEL KEY
TOP ROW: TOTAL POP (IN 100'S (RES)
MIDDLE ROW: OI (RES) CR VR (NR)
BOTTOM ROW: % OCCUPANCY (RES)
PARCEL EDGES
INTERSECTIONS
* TYPE 1 TERMINAL
X TYPE 2 TERMINAL
* TYPE 3 TERMINAL

5. Topographical Restriction Map

This map shows the percent of a parcel that may not be purchased or developed by any local decision-makers. Land that is topographically undevelopable includes mountains, rock outcrops, swamps. None of the area consumed by water bodies represented in the local system (large lakes, small lakes, and rivers) is shown on this map. The map also shows jurisdictional boundaries, the road network, and the location of terminals.

Figure 10.25

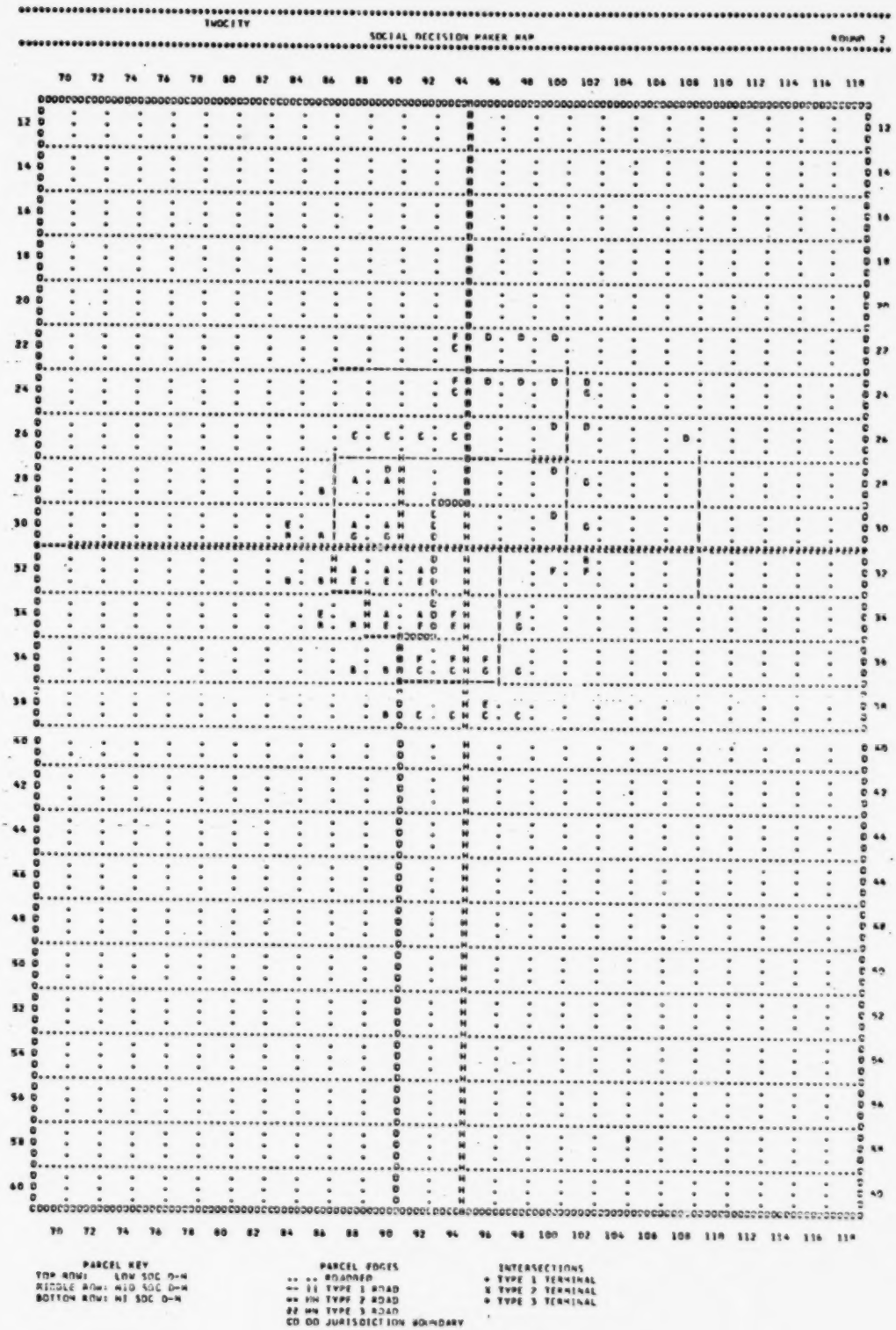

TWOCITY
TOPOGRAPHICAL RESTRICTION MAP
PARCEL KEY
PERCENT TOPOGRAPHICALLY UNDEVELOPABLE
PARCEL PROFS
ROADDED
TYPE 1 ROAD
TYPE 2 ROAD
TYPE 3 ROAD
JURISDICTION BOUNDARY
INTERSECTIONS
TYPE 1 TERMINAL
TYPE 2 TERMINAL
TYPE 3 TERMINAL

6. Social Decision Maker Map

This map indicates which social players make decisions for the low, middle, and high income population units on parcels. The top letter on a given parcel represents the social decision-maker who controls the PL's who live there, and the middle and lower letters represent the social decision-makers who control the PM's and PH's, respectively, who live there. If a particular class does not live on a parcel, no letter is printed.

Not until a parcel is developed for residential land use and occupied by at least one income class, will a social decision-maker for that parcel appear on the map. Note that different decision-makers may control the different population classes on a single parcel. Social teams acquire control over additional Pl's on a parcel when the number of Pl's of that class moving into the parcel exceeds the number moving out. Social teams may find that from round to round they gain or lose control of population units on a residential parcel of land. This occurs as a result of the migration of Pl's of a class to a parcel where previously there were no Pl's of that class (a gain) or as a result of the migration away from a parcel of all the Pl's of a class on that parcel.

Figure 10.24


IMOCITY
SOCIAL DECISION MAKER MAP
ROUND 2
PARCEL KEY
TOP ROW: LOW SOC D=H
MIDDLE ROW: MID SOC D=H
BOTTOM ROW: HI SOC D=H
PARCEL EDGES
== == BOUNDED
-- -- TYPE 1 ROAD
== HH TYPE 2 ROAD
TYPE 3 ROAD
CO OO JURISDICTION BOUNDARY
INTERSECTIONS
+ TYPE 1 TERMINAL
X TYPE 2 TERMINAL
* TYPE 3 TERMINAL

C. Summary Information

1. Demographic and Economic Statistics

The output summarizes a wide variety of information about the simulated region. There are two basic types of information: statistics by jurisdiction and for the region as a whole about local conditions, and measures of interactions between the region and the Outside System. The former provide comparisons between jurisdictions; the latter provide comparisons between the local and Outside systems.

Statistics Regarding Local Conditions

Total population: the number of people (not Pl's), by class.

Percent change over previous year: the total population change, positive or negative, between the current round and the previous round. This is the only local statistic which is given only as a total and not broken down by jurisdiction.

Average population per parcel: the number of people divided by the number of parcels.

Developed land (in parcels): the amount of land area (in parcel equivalents) consumed by public and private developments.

Undeveloped land: the amount of land area (in parcel equivalents) not consumed by developments.

Total land area: the number of parcels.

Assessed value of land in millions: the property tax base.

Assessed value of developments in millions: the development tax base.

Average quality of life index: a measure across classes of the people's average quality of life index. The higher the index, the poorer the quality of life. The indexes may differ significantly within a jurisdiction, but only averages are given here.

Number of registered voters: the number of people eligible to vote, from which the number who actually vote are selected.

Figure - 9.1

TWOCITY

DEMOGRAPHIC AND ECONOMIC STATISTICS

ROUND 1

	TOTAL	JURISDICTION I	JURISDICTION II	JURISDICTION III
TOTAL POPULATION	275500	126000	149500	0
LOW CLASS	73500	0	73500	0
MIDDLE CLASS	99000	64000	35000	0
HIGH CLASS	103000	62000	41000	0
PERCENT CHANGE OVER PREVIOUS YEAR	0			
AVERAGE POPULATION PER PARCEL	0	0	0	0
DEVELOPED LAND (IN PARCELS)	77	30	46	0
UNDEVELOPED LAND	548	266	283	0
TOTAL LAND AREA	625	296	329	0
ASSESSED VALUE OF LAND IN MILLIONS	12312.	5321.	6992.	0.
ASSESSED VALUE OF DEVELOPMENTS IN MILLIONS	421.	158.	264.	0.
AVERAGE QUALITY OF LIFE INDEX	69	61	75	0
NUMBER OF REGISTERED VOTERS	88573	45566	43007	0
NO. IN PUBLIC ADULT EDUCATION	0	0	0	0
AVERAGE EDUCATIONAL LEVEL	59	73	47	0
LOW	17	0	17	0
MIDDLE	61	61	62	0
HIGH	5232824	4061270	278305	0
NO. OF WORKERS RECEIVING WELFARE	12800	0	12800	0
STUDENT/TEACHER RATIO	7	13	10	0
SCHOOL ENROLLMENT				
PUBLIC	48740	34040	14700	0
PRIVATE	20460	0	20460	0
HOUSING UNITS				
SINGLE DWELLINGS	100	62	38	0
MULTIPLE DWELLINGS	24	7	17	0
HIGH RISE APARTMENTS	6	4	2	0
VACANCY RATE (PERCENT)	4	28	-23	0
NEGATIVE MEANS OVERCROWDED				

Figure - 9.1 (Cont'd)

NUMBER OF EMPLOYED WORKERS	79400	35360	44040	0
LOW	23000	0	23000	0
MIDDLE	31680	20480	11200	0
HIGH	24720	14880	9840	0
NUMBER EMPLOYED IN				
LIGHT INDUSTRY	27160	10240	16920	0
HEAVY INDUSTRY	27760	11800	15960	0
NATIONAL SERVICES	0	0	0	0
CONSTRUCTION INDUSTRY	0	0	0	0
BUSINESS GOODS	2800	1680	1120	0
BUSINESS SERVICES	5240	0	5240	0
PERSONAL GOODS	3360	3360	0	0
PERSONAL SERVICES	5680	2480	3200	0
MUNICIPAL SERVICES	1920	1920	0	0
SCHOOLS	3880	3880	0	0
RAIL	0	0	0	0
BUS	0	0	0	0
FEDERAL-STATE	1600	0	1600	0
NUMBER OF UNEMPLOYED WORKERS	6400	0	6400	0
LOW	6400	0	6400	0
MIDDLE	0	0	0	0
HIGH	0	0	0	0
UNEMPLOYMENT RATE (PERCENT)	7.46	0.0	12.69	0.0
LOW	21.77	0.0	21.77	0.0
MIDDLE	0.0	0.0	0.0	0.0
HIGH	0.0	0.0	0.0	0.0
PERCENT EARNING UNDER $ 5,000	33	5	55	0
PERCENT EARNING $5,000 TO $10,000	37	54	22	0
PERCENT EARNING OVER $10,000	29	39	21	0

Number in public adult education: the number of people who wanted to participate in public adult education programs and were able to do so because programs were provided by their school departments.

Average educational level: by class, the average educational level. This ranges from 0 to 100. The higher a worker's educational level relative to those of other workers, the greater his chances of being hired before the others.

Number of workers receiving welfare: if a jurisdiction does have a program for aid to the unemployed, this number is the number of unemployed workers. The number is zero if there are either no unemployed workers or no welfare program.

Student/teacher ratio: ratio of number of students attending local public schools to number of teachers employed by public schools. This is a factor when students are allocated to public or private schools.

School enrollment: the number of students attending local public schools and the number attending private schools. Students attend private schools only if the public schools in their districts are inadequate.

Housing units: the number of levels of RA (single family), RB (town house, multiple dwellings), and RC (high rise) housing.

Vacancy rate: the ratio of existing housing space to housing space occupied, expressed as a percent. A negative rate means that housing is overcrowded.

Number of employed workers: the number of people holding full-time jobs, by class of worker.

Number employed by type of employer: the number of full-time workers employed by each type of business and government employer.

Number of unemployed workers: by class, the number of workers seeking full-time employment who were unable to obtain jobs.

Unemployment rate (percent): by class, the number of unemployed workers as a percent of the total number of workers who sought full-time jobs.

Earning distribution: the percent of workers earning less than $5,000, between $5,000 and $10,000, and over $10,000 from full-time employment.

Transactions With the National Economy

Income from the national economy: federal-state aid received, by type of aid, and income from both basic industry sales of output and bus and rail sales of equipment.

Sales to the national economy: federal-state taxes paid, by type of tax, and purchases of goods, services, and outside-owned land. The only Outside expenditure which can be significantly controlled locally is the purchase of goods and services due to local insufficiency.

National economy business cycle: last round's ratio to "typical income"per unit of output for basic industry, interest rates on loans and bonds from the Outside (expressed as percents), and the average rate of return on outside investments (expressed as percents).

D. Highway Department Output

The Highway Department controls the construction of roads and terminals and the maintenance of roads. Roads are located between parcels and consume land from both adjoining parcels; a terminal is located at corners of parcels (intersection) and consumes land from the four parcels which border the intersection. Roads are used by population units to travel to and from employment and shop locations and by basic industry and commercial establishments to transport products to terminals and to purchase the necessary goods and services for maintenance and normal operations. Population units travel to work during peak-hour travel only.

There are three types of highways: HY1, HY2, HY3. An HY3 is the largest road, and the cheapest to travel on. The type of road determines its design capacity in terms of the number of vehicles which it can handle without congestion when it is in the best condition. Highways depreciate as a function of use. The value ratio of a segment of highway is the percent of its design capacity which it can actually handle. The lower the value ratio of a road, the less its effective capacity.

Road congestion occurs when there are more vehicles using a road segment than can be handled by the road. Congestion is recorded only during peak-hour travel. When congestion occurs, it takes additional time for population units to travel along the congested road segment. The amount of additional time is directly proportional to the amount of congestion on the highway. For example, if the peak-hour congestion is 110%, the time to travel a road is 10% greater than otherwise. Time consumed in transportation to and from work affects the allocation of leisure time in the social sector.

Terminals are used by heavy industry, light industry, and business goods. Industries use terminals to ship output to national demanders and BG receives goods from national suppliers.

1. Highway Department Finances

The Highway Department receives income to its current and capital accounts from various sources. These include appropriations, Federal-State aid, bonds, and miscellaneous income. Appropriations are distributed to the current and/or capital accounts of the department by the Chairman. The

Figure 8.14

TWOCITY — HIGHWAY DEPARTMENT FINANCES — JURISDICTION 1 — ROUND 1

FINANCIAL REPORT

CAPITAL		CURRENT	
PREVIOUS BALANCE	$ 0.0	PREVIOUS BALANCE	$ 0.0
REVENUES		REVENUES	
APPROPRIATIONS	$ 0.0	APPROPRIATIONS	$ 500000.00
FEDERAL/STATE AID	0.0		
NEW BONDING	0.0	NEW BONDING	270000.00
MISCELLANEOUS	0.0	MISCELLANEOUS	0.0
TOTAL REVENUE	$ 0.0	TOTAL REVENUE	$ 770000.00
EXPENDITURES		EXPENDITURES	
ROAD CONSTRUCTION	$ 0.0	ROAD MAINTENANCE	$ 406222.00
TERMINAL CONSTRUCTION	0.0	BOND PAYMENTS	354766.00
LAND PURCHASE	0.0		
MISCELLANEOUS	0.0	MISCELLANEOUS	0.0
TOTAL EXPENDITURES	$ 0.0	TOTAL EXPENDITURES	$ 760988.00
NEW BALANCE	$ 0.0	NEW BALANCE	$ 9012.00

OUTSTANDING BONDS

TYPE	ORIGINAL PRINCIPAL	REMAINING TERM	INTEREST RATE	ANNUAL PAYMENT
CAPITAL	3332474.	13	9.0	736447.
CURRENT	270000.	2	3.0	141104.

MAINTENANCE

ROAD TYPE	MAINTENANCE LEVEL	TOTAL MILES	AVERAGE DEPRECIATION BEFORE MAINTENANCE	COST
1	90.0	10	0.4	$ 48000.
2	90.0	12	0.5	$ 100445.
3	90.0	11	1.0	$ 257778.

Figure 8.14 (Cont'd)

ROAD CONDITIONS BEFORE MAINTENANCE

VALUE RATIO	ROADS														
95 - 99	9514	9516	9522	8823	9023	9223	9423	8827	8728	9128	9130	7331	7231	7431	7631
	0	0	0	0	0	0	0	4	0	0	1	0	0	0	0
	7831	8031	8231	8431	9136	8730									
	0	0	0	0	0	0									
90 - 95	9526	9027	9227	9427	9231	8631	8831	8732	9031	8833	8934	9035			
	31	29	29	57	99	10	44	35	68	26	19	13			

THERE ARE NO ROADS IN THIS JURISDICTION WITH VALUE RATIOS BELOW 85

TERMINALS

UNDEVELOPED LAND

LOCATION	AMOUNT	LOCATION	AMOUNT	LOCATION	AMOUNT	LOCATION	AMOUNT	LOCATION	AMOUNT
86-22	4	88-22	4	90-22	4	92-22	4	94-22	4
86-24	4	88-24	4	90-24	4	92-24	4	94-24	4

FEDERAL STAFF AID AVAILABLE FOR HIGHWAY CONSTRUCTION

NONE

department must request Federal-State aid for road construction from the computer and if it is granted, the aid can be used only for the approved project. The department does not receive the aid until the approved project is performed. Current bonds are automatically floated by the computer if the current expenditures of the department exceed its current revenue. Current bonds have a duration of two years and the interest rate is set by the computer. Capital bonds may be floated for the department by the Chairman subject to a referendum by the social sector. Capital bonds have a duration of 25 years and the interest rate is set by the computer. Miscellaneous income includes such items as cash transfers to the capital or current account of the department and income from the sale of land (capital account only).

The Highway Department spends money on road maintenance, bond payments, miscellaneous, construction and land purchase.

The Highway Department must purchase business goods (BG) and business services (BS) for the maintenance and/or renovation of its roads. BG and BS are purchased by the Highway Department at fixed costs from the Outside System. Bond payments include payments on interest and principal of outstanding capital and current bonds floated by the department. Miscellaneous expenditures involve cash transfers from the capital or current accounts of the department to an economic, social, or governmental decision-maker, or from one account to another account.

Each outstanding bond is listed on the bond table, one row per bond. The first item is the type of bond, capital or current. A capital bond has a term of 25 years; a current bond has a term of 2 years. The original principal, remaining term, interest rate, and annual payment are given. The remaining term is the number of rounds <u>after</u> the current round in which the department must make the annual payment. The annual payment is calculated by the computer to pay off the bond in equal installments each year, and the payment is made automatically by the computer from the department's current account.

Below the outstanding bond table is a table which shows the maintenance level, number of segments, and average depreciation of each road type. The Highway Department specified a road maintenance level by road type, not for each individual road segment.

The next table shows the location of road segments at each value ratio (depreciated value before maintenance). Below a road's coordinates is its congestion, the amount which the road is used in peak-hour transportation in excess of its effective capacity. If a road showed a congestion of 30, it would have 30% more use it could effectively handle.

The detail on terminals shows the location, level, design capacity (in terminal units), and terminal units used there.

The location and amount of land (in percent of a parcel) is shown for all undeveloped land owned by the department.

Last, a table shows the locations of roads for which Federal-State aid has been granted but which have yet to be constructed. The road type for which the aid has been approved is also shown.

2. Highway Department Construction Table

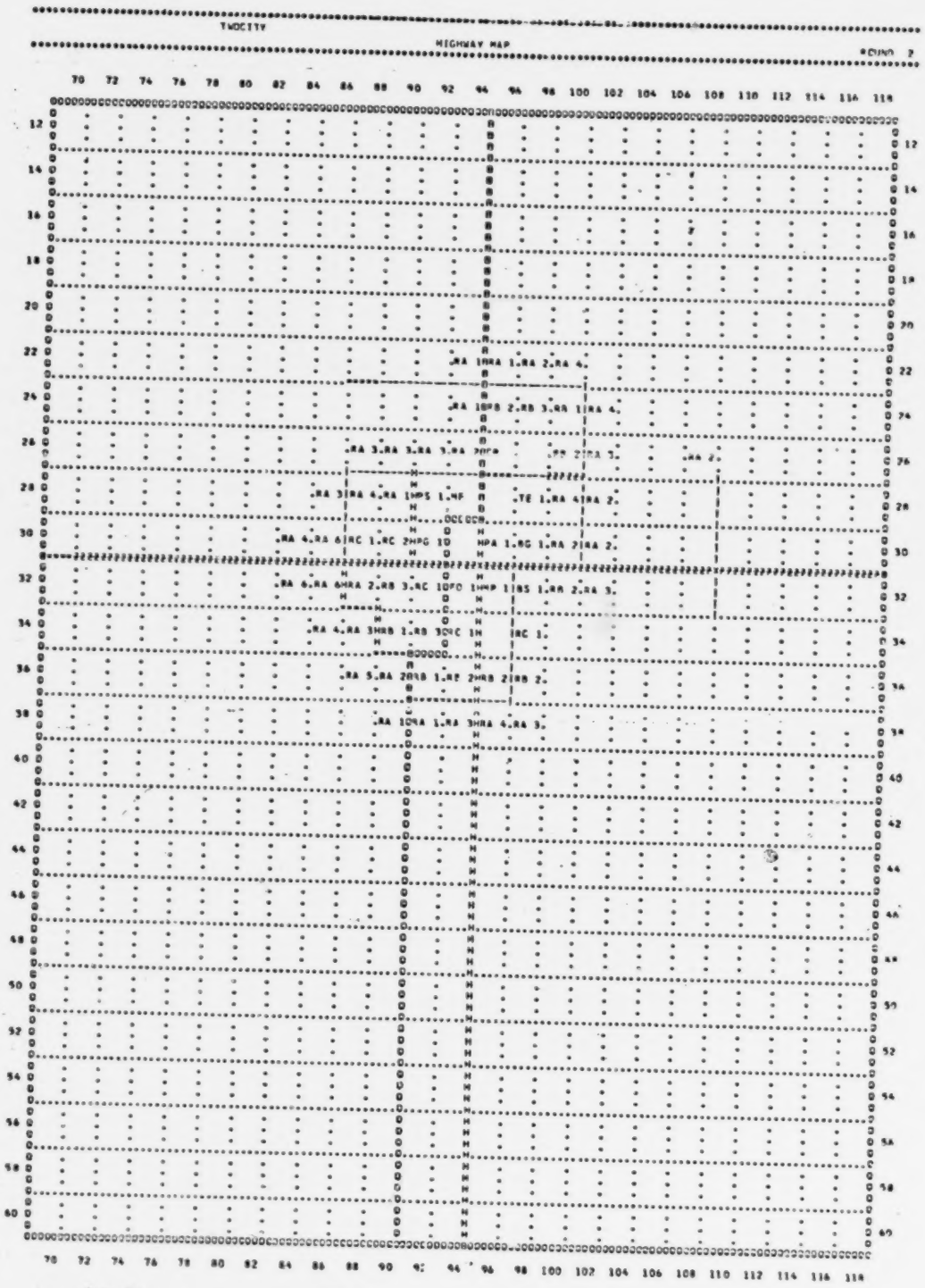
This output shows the site location, type of construction (road or terminal), and old and new level of development of all construction or demolition decisions input by the department and accepted by the computer during the previous round.

3. Highway Map

This map designates the location and level of roads and terminals. Roads may be built in the roadbeds which are located along the sides of the parcels of land. Roads may be built at one of three operating levels (1 through 3, with 3 being the largest capacity road). Road locations are identified by a coordinate pair that consists of an even and an odd number. For example, 7011 is the east-west road at the upper left portion of the map and 6912 is the north-south road at the upper left portion of the map. [Roads may not be built along the extreme right boundary (line 119) or along the extreme bottom boundary (line 61) of the map.]

Terminals may be built at one of three service levels (with level 3 being the largest capacity terminal). Terminals are located at the intersections of roads or roadbeds. Business activities that use terminals are assigned to specific terminal locations taking into account accessibility and terminal capacity.

Figure 10.19


TWOCITY
HIGHWAY MAP
PARCEL KEY
LAND USE AND LEVEL
PARCEL EDGES
INTERSECTIONS
TYPE 1 TERMINAL
TYPE 2 TERMINAL
TYPE 3 TERMINAL

V. Types of Decisions Available to the Highway Department

A. Summary of Decisions

These decisions which the Highway Department can make fall into two categories: those which are jurisdiction-wide in scope and those that pertain to individual locations.

- Jurisdiction-wide
  - Transfer Cash
  - Change Maintenance Level of A Road Type
  - Request Federal-State Aid For Road Construction
- Individual Locations
  - Buy or Sell Land
  - Construct or Demolish Roads or Terminals

The department can make as many of each of these decisions as it wishes. The department can also choose to make no decisions. If no decisions are made, no cash or land is transferred and no new Federal-State aid is granted. Roads and terminals remain the same as in previous rounds, and roads are maintained at the previous maintenance levels.

B. Input Format

Local system decision-makers (such as the Highway Department) use a standardized input form (Figure HY-3.2) when making decisions that must be processed by the computer.

The standard message format is:

$CODE/ = dm/a, b, c, d, ...

1. $CODE stands for the type of decision code. The Highway Department has the option to make decisions that use the following decision codes:

$OTHER (maintenance)
$CASH (transfer cash)
$PU (land transfer)
$OUBLD (construct or demolish)
$FSA (request Federal-State aid)

2. "=dm" is the decision-maker, which for the Highway Department is HY1, HY2, or HY3, depending upon the appropriate jurisdiction number. A jurisdiction number must always follow the HY decision-maker code even if there is only one active jurisdiction.

3. The columns "a", "b", and so forth are filled in with the appropriate information depending upon the particular decision.

Note that there is a slash (/) after the decision code and after the decision-maker code. There are commas separating all other bits of information. Note also that the decision-maker code is prefaced by an equals sign (=).

INPUT FORM

RIVER BASIN MODEL

Note: When filling out this form, refer to input description form in the manual.

Please write clearly; distinguish between 1 (one) and "I" (eye), "Ø" (oh) and "0" (zero); be sure to fill in numbers exactly as required; omitting commas within numbers (100000).

Decision Code	Decision-Maker	a	b	c	d	e	f	g	h	i	j	k
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____
$_____ /	=_____ /	____,	____,	____,	____,	____,	____,	____,	____,	____,	____,	____

HIGHWAY DEPARTMENT: INPUT EXPLANATION FORM

Type of Decision	Code	Decision Maker	a	b	c	d	e
Purchase or bid on land	$PU	HY1, HY2 or HY3	location	price (in $1000's)	seller economic decision-maker or department and jurisdiction or OU)	percent of parcel (o if all)	
Change Maintenance Level	$OTHER	HY1, HY2 or HY3	M	new maintenance level	type of road (1, 2, or 3)		
Construct, upgrade or demolish a road or terminal by the "Outside System"	$OUBLD	HY1, HY2 or HY3	site location	HY if road TM if terminal	old level (0 if new road or terminal)	new level (0 if demolition)	if on jurisdiction boundary, jurisdictio numbers, separated by commas
Request federal-state aid	$FSA	HY1, HY2 or HY3	new level for which aid requested (1, 2, or 3)	Location of road for which aid is requested			

HIGHWAY DEPARTMENT: INPUT EXPLANATION FORM

Type of Decision	Code	Decision Maker	a	b	c	d	e
Transfer Cash	$CASH	HY1, HY2 or HY3	C	receiver (economic or social decision-maker or department and jurisdiction)	amount (in dollars)	from CAPital or CURrent account	if economic decision-maker is receiving, PVT; if social receiving, class receiving (H,M, or L); if department is receiving, to CAPital or CURrent account

f	g
0	If social receiving, location receiving

C. Sample Decisions

(The input format is shown on the sample input. Note that the jurisdiction number must always be given even if only a single jurisdiction exists.)

Jurisdiction-Wide Decisions

1. Transfer Cash

Case 1: The Highway Department in Jurisdiction 3 wishes to transfer $6,000,000 from its current account to its capital account.
Case 2: The same department wishes to give the low-income residents controlled by BB on parcel 9832 a total of $80,000 (to be divided among the Pl's) from its capital account for agreeing to allow the new superhighway to replace parkland on their residence parcel.

2. Change Road Maintenance Levels

The Highway Department in Jurisdiction 1 decides to maintain all of the Type 3 roads in the jurisdiction at a value ratio of 98.

3. Request Federal-State Aid

The Highway Department in Jurisdiction 2 requests aid for a Type 2 road at 9833, 9633, 9433, and 9233. This stretch of road will have no gaps or turns, so it can be "block input".

Location - Specific Decisions

4. Buy or Sell Land

Case 1: The Highway Department in Jurisdiction 3 wishes to build a new road at 108-31, and it has agreed to purchase 8% of 108-30 for $32,000 from its economic owner, team D, and 8% of 108-32 for $10,000 from the Utility Department, which owns some undeveloped land there.
Case 2: The same Highway Department gives the Utility Department 4% of 112-28 for free as part of the same deal. (Note that the new owner is designated as the decision-maker.)

5. Construct or Demolish Roads and Terminals

Case 1: The same Highway Department builds a Type 1 road at 108-31, for which it has just obtained land.
Case 2: The Highway Department in Jurisdiction 1 increases the size of a terminal at 83-29 from level 2 to level 3 near an expanding community. It already owns sufficient land at 82,28, 84-28, 82-30, and 84-30 for the construction.

SAMPLE DECISION INPUTS FOR THE HIGHWAY DEPARTMENT

	Decision Code	Decision-Maker	a	b	c	d	e	f	g
1.1	$CASH / =	HY3 /	C,	HY3,	6000000,	CUR,	CAP,	____,	____
1.2	$CASH / =	HY3 /	C,	B[illegible],	80000,	CAP,	L,	0,	9832,
2	$ØTHER / =	HY1 /	M,	98,	3,	____,	____,	____,	____,
3	$FSA / =	HY2 /	2,	(9833 > 9233),		____,	____,	____,	____,
4.1	$PU / =	HY3 /	10830,	32,	D,	8,	____,	____,	____,
4.1	$PU / =	HY3 /	10832,	10,	UT3,	8,	____,	____,	____,
4.2	$PU / =	UT3 /	11228,	0,	HY3,	4,	____,	____,	____,
5.1	$ØUBLD / =	HY3 /	10831,	HY,	0,	1,	____,	____,	____,
5.2	$ØUBLD / =	HY1 /	8329,	TM,	2,	3,	____,	____,	____,

VI. MASTER SHEETS

A. MASTER TABLE FOR THE HIGHWAY DEPARTMENT
(Characteristics for Level One Unless Stated Otherwise)

Facility	Highways	Terminals
LOCATION REQUIREMENTS	HY	TM
Percent of Parcel	(from both sides)	(from 4 corners)
Level 1	8	12
Level 2	12	16
Level 3	16	20
CONSTRUCTION COSTS (Millions of Dollars)	.8	14
DEPRECIATION		
Due to Use	5.0 Z[a)]	NA
ROAD MAINTENANCE		
Purchases per 1% Maintenance	$20,000/segment	NA
CAPACITY MEASURES		
Design Capacity (standardized units)	500/segment	10,000
Consumption by Users (standardized units)		
P1	10	
BUS (level 1)	50	
BG		1 per CU sold
FL,NL,EL,TA		1000
MF,TE		2000
FO,PA,CR		3000
MP		6000
SG		10000

FEDERAL-STATE AID FOR CAPITAL CONSTRUCTION	Matching Federal	Matching Local	Probability of Receiving Aid
ROAD TYPE			
Level 1	$1	$9	80%
Level 2	$1	$1	50%
Level 3	$2	$1	30%

Limit on the number of road segments requested by a jurisdiction is 5.

NOTE: a) Z = highway units used/effective capacity and, effective capacity is the design capacity times the value ratio expressed as a percent.

B. PLANNING MASTER TABLE
(LEVEL ONE CHARACTERISTICS)

ACTIVITY	Percent of a Parcel (Maximum Possible Levels)	Minimum Level of Utility Service	Annual Utility Units Consumed	Construction Costs (Market Value)	Full Time Employees PH	PM	PL	Terminal Units	MS Drain (MS Capacity Units)
FL	28 (3)	1	50	300	8	8	35	1000	150
SG	40 (2)	1	100	240	14	18	23	10000	50
MP	48 (2)	7	700	240	19	18	18	6000	200
MF	20 (5)	1	100	320	24	18	17	2000	150
NL	15 (6)	1	100	150	21	20	18	1000	100
EL	12 (8)	2	200	140	30	18	17	1000	150
TE	12 (8)	2	200	180	25	22	15	2000	200
FO	20 (5)	3	300	230	15	19	24	3000	250
TA	6 (16)	1	100	120	15	10	30	1000	150
PA	16 (6)	3	300	250	23	17	20	3000	200
CR	28 (3)	4	400	250	24	24	14	3000	300
NS	12 (8)	1	76	50	23	9	9	NA	50
BG	12 (8)	2	112	25	14	7	8	One per CU sold	25
BS	10 (10)	1	71	10	20	9	9	NA	10
PG	12 (8)	1	99	30	8	13	23	NA	30
PS	12 (8)	1	77	10	6	11	16	NA	10
RA	2 (50)	1	4	1	NA	NA	NA	NA	10
RB	2 (50)	1	26	6	NA	NA	NA	NA	60
RC	2 (50)	2	117	25	NA	NA	NA	NA	250

C. OPERATION OF FEDERAL-STATE AID

Department	Basis	Matching Federal	Matching Local	Limit on Number of Requests per Jurisdiction	Probability of Receipt
School					
Current Aid	$225/student			N.A.	Automatic (no request needed)
Capital Aid	Match dollar for dollar			3	60% (1st request) 40% (2nd request) 30% (3rd request)
Highways	Type of Road				
Capital Aid	I	$1	$9	5 road segments	80%
	II	$1	$1		50%
	III	$2	$1		30%
Municipal Services					
Current Aid	Two Federal-State dollars for each local dollar up to maximum total paid of $35 per resident of the jurisdiction			N.A.	Automatic

APPENDIX A

Sequence of Computer Print-Out

Although sections of the computer output can be distributed in any order and in any combination to players, it is printed in a fixed order with which the director should become familiar. The overall order of output is:

1. Migration
2. Water System
3. Employment
4. Commercial Allocation
5. Social Sector
6. Economic Sector
7. Social and Economic Summaries
8. Government Detail
9. Summary Statistics
10. Maps

Within each of these major output sections there are several subsections. An additional section of print-out results from the processing of decisions on a data base. That print-out, called EDIT, has no fixed sequence within it; the order of decision input is the order in which EDIT processes and lists player and director decisions. The EDIT print-out is separate from the print-outs listed above. These print-outs reflect the simulated region's status in response to the previous year's data base and any changes made to it through EDIT.

Each subsection of output has its own title, but on every subsection the heading for the data base and the round number are printed. A list of the titles of print-out sections in the order in which they are printed and a description of each are given below and are summarized in Figure 4.

Print-Out Section	Description
1. Migration	
Environmental Indexes	For each class which can live on each residence parcel, this shows the value of each component of the environmental index based on last round's pollution index, MS use index and school use index and this round's residence quality, rent, tax rates, and welfare rates.

Figure 4

RIVER BASIN MODEL OUTPUT

1. Migration
   - 1.1 Environmental Indexes
   - 1.2 Personal Indexes
   - 1.3 Dissatisfaction Cutoffs
   - 1.4 Migration Detail
   - 1.5 Migration Statistics
   - 1.6 Migration Summary

2. Water System
   - 2.1 Water User Effluent Content
   - 2.2 River Quality During Surface Water Process
   - 2.3 Water User Costs and Consumption
   - 2.4 Coliform and Pollution Index Values

3. Employment
   - 3.1 Employment Selection Information for PL Class
   - 3.2 Employment Selection Information for PM Class
   - 3.3 Employment Selection Information for PH Class
   - 3.4 Part-Time Work Allocation for PH Class
   - 3.5 Part-Time Work Allocation for PM Class
   - 3.6 Part-Time Work Allocation for PL Class
   - 3.7 Employment Summary

4. Commercial Allocation
   - 4.1 Personal Goods Allocation Summary
   - 4.2 Personal Services Allocation Summary
   - 4.3 Business Goods Allocation Summary
   - 4.4 Business Services Allocation Summary
   - 4.5 Government Contracts
   - 4.6 Terminal Demand and Supply Table
   - 4.7 Terminal Allocation Map

5. Social Sector
   - 5.1 Dollar Value of Time
   - 5.2 Social Decision-Maker Output
   - 5.3 Social Boycotts

6. Economic Sector
   - 6.1 Farm Output
   - 6.2 Residence Output
   - 6.3 Basic Industry Output
   - 6.4 Commercial Output
   - 6.5 Economic Boycott Status
   - 6.6 New Construction Table
   - 6.7 Land Summary
   - 6.8 Loan Statement
   - 6.9 Financial Summary

7. Social and Economic Summaries
   - 7.1 Number of Levels of Economic Activity Controlled by Teams
   - 7.2 Employment Centers
   - 7.3 Economic Control Summary for Teams
   - 7.4 Social Control Summary for Teams
   - 7.5 Social Control Summary Totals
   - 7.6 Economic Graphs for Teams
   - 7.7 Social Graphs for Teams

8. Government Detail
   - 8.1 Assessment Report
   - 8.2 Water Department Reports
   - 8.3 Sampling Station Report: Point Source Quality
   - 8.4 Sampling Station Report: Ambient Quality
   - 8.5 Utility Department Report
   - 8.6 Utility Department Finances
   - 8.7 Municipal Services Department Report
   - 8.8 Municipal Services Department Finances
   - 8.9 Municipal Services Department Construction Table
   - 8.10 Planning and Zoning Department Report
   - 8.11 School Department Report
   - 8.12 School Department Finances
   - 8.13 School Department Construction Table
   - 8.14 Highway Department Finances
   - 8.15 Highway Department Construction Table
   - 8.16 Rail Company Report
   - 8.17 Bus Company Report
   - 8.18 Chairman Department Finances
   - 8.19 Tax Summary
   - 8.20 Financial Summary

9. Summary Statistics
   - 9.1 Demographic and Economic Statistics

10. Maps
   - 10.1 Personal Goods Allocation Map
   - 10.2 Personal Services Allocation Map
   - 10.3 Business Commercial Allocation Map
   - 10.4 Municipal Service Map
   - 10.5 School Map
   - 10.6 Utility Map
   - 10.7 Water Usage Map
   - 10.8 Water Quality Map
   - 10.9 Municipal Treatment
   - 10.10 Municipal Intake and Outflow Point Map
   - 10.11 Surface Water Map
   - 10.12 Farm Runoff Map
   - 10.13 River Basin Flood Plain Map
   - 10.14 Farm Map
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   - 10.20 Planning and Zoning Map
   - 10.21 Parkland Usage Map
   - 10.22 Socio-Economic Distribution Map
   - 10.23 Demographic Map
   - 10.24 Social Decision-Maker Map
   - 10.25 Topographical Restriction Map
   - 10.26 Government Status Map

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Print-Out Section	Description
Personal Indexes	For each class living on each residence parcel, this shows the value of each component of the personal index based on last round's time allocation, residential crowding, MS use index, and coliform bacteria index.
Migration Detail	For each residence parcel and for each class which lived on the parcel immediately before or after the migration program ran, this shows the number of Pl's in the class now residing on the parcel and of those who moved, why they moved and where they came from and went to.
Migration Statistics	Number of in-migrants, out-migrants, internal migrants, and natural population growth by jurisdiction and class.
Migration Summary	The number of Pl's who moved between or within jurisdictions by class, by jurisdiction and by reason for moving.

2. Water System

Water User Effluent Content	For each economic activity and municipal water system, the volume of effluent dumped into the surface water and the amount of each pollutant in the effluent after the effluent has received any treatment.
River Quality During Surface Water Process	For each of the five stages in the surface water process and for the surface water on each parcel through which a river flows, this shows the water quality rating, the volume of water, and the amount of each pollutant present.

Print-Out Section	Description
Water User Costs and Consumption	This shows for each economic activity the amount of water which it required, the amount which it obtained from its normal source and the cost which it paid to purchase water, to treat its intake water, to recycle water and to treat its effluent.
Coliform and Pollution Index Values	Map showing, for each parcel containing surface water, the coliform count and the water quality rating. The pollution indexes for such parcels and for parcels bordering parcels containing surface water are also shown.

3. Employment

Employment Selection Information for Low-Income Class	Tabular output showing the place of residence of all Pl's, their employers, the number of Pl's not employed and employed by each employer, the salary of each employer, the time units consumed in transportation to work, the cost of using an auto to go to work, the costs using a bus and/or rail to go to work, and the route used to travel to work whether by auto or public transit.
Employment Selection Information for Middle Income Class	Tabular output showing the place of residence of all Pl's, their employers, the number of Pl's not employed and employed by each employer, the salary of each employer, the time units consumed in transportation to work, the cost of using an auto to go to work, the costs using a bus and/or rail to go to work, and the routes used to travel to work whether by auto or public transit.

Print-Out Section	Description
Employment Selection Information For High Income Class	Tabular output showing the place of residence of all Pl's, their employers, the number of Pl's not employed and employed by each employer, the salary of each employer, the time units consumed in transportation to work, the cost of using an auto to go to work, the costs using a bus and/or rail to go to work, and the routes used to travel to work whether by auto or public transit.
Part-Time Work Allocation For High Income Class	Tabular list of residence location of part-time workers, their employers, the number of part-time units spent working, and the yearly salary rate.
Part-Time Work Allocation for Middle Income Class	Tabular list of residence location of part-time workers, their employers, the number of part-time time units spent working and the yearly salary rate.
Part-Time Work Allocation for Low Income Class	Tabular list of residence location of part-time workers, their employers, the number of part-time time units spent working and the yearly salary rate.
Employment Summary	Information by class and total for the number of Pl's employed at their design level or at lower levels, the number unemployed, the total number of Pl's, the part-time units worked, and the number of jobs full time that were not filled by the local labor force.

4. Commercial Allocation

Personal Goods Allocation Summary	Tabular output showing the identification number assigned to each PG establishment, its

Print-Out Section	Description
	location, owner, level, effective capacity, actual capacity used, price, and gross sales. For each customer it shows the store to which it is assigned, the customer location and type or class, the customer's owner, the consumption units (including those for maintenance and recreation), transportation costs (shadow costs in the case of residences) the purchase cost (total cost in the case of residences), and total cost.
Personal Services Allocation Summary	This is identical in format to the Personal Goods Allocation Summary but gives details regarding personal services.
Business Goods Allocation Summary	For businesses which require business goods, the format is the same as for personal goods. In addition, there is a section called Government Contracts which shows, for each school and MS department, how many consumption units it purchases from each business goods establishment.
Business Services Allocation Summary	This is identical in format to the Business Goods Allocation Summary but gives details regarding business services.
Terminal Allocation Summary	Tabular list of the location, business type (land use), and terminal requirements of each terminal user. Each terminal is assigned an identification number and its location, level, and usage are noted.

Print-Out Section	Description
Terminal Allocation Map	Map showing the code number of the terminal to which each terminal user in the local system is assigned.
5. Social Sector*	
Dollar Value of Time	This table shows, by team and by class, the dollar value of a time unit spent in travel.
Social Decision-Maker Output	By jurisdiction, by social decision-maker, and by class, a table in which each social characteristic is a row and each residence parcel is a column. The characteristics are descriptive and financial.
Social Boycotts	Detail on who is boycotting, what function they are boycotting, and similar details about social boycotts appear on this output.
6. Economic Sector**	
Farm Output	Tabular list, one row per farm, showing the farm code number, farm type, number of parcels comprising the farm, number of percents of parcels comprising the farm, the farm's fertilizer level, normal income, actual income, land taxes, and total net income.

*The dollar value of time prints a table for each jurisdiction, although at this time the value is set for a team and class without regard to jurisdiction. The rest of the social detail prints in order of jurisdiction number, within that in alphabetical order, and within that in order of class (low first, high last). Output for any classes which a team does not control in a jurisdiction is not printed. Likewise, a class having no boycotts receives no boycott output.

**The economic output prints by team in alphabetical order. All of a single team's output is printed before the next team's output begins. A team for which a section of output is irrelevant does not receive that section of output. For example, a team with no residences receives no residence output. Likewise, a team which has no loans outstanding as either a debtor or a creditor does not receive a loan summary. All active teams receive financial summaries.

Print-Out Section	Description
Residence Output	Tabular list of descriptive and financial information about each residence parcel which the decision-maker controls.
Business Output	Tabular list of descriptive and financial information about each business which the decision-maker controls. All basic industries are grouped together and precede the group of personal commercial and business commercial.
Construction Industry Output	Tabular list of descriptive and financial information about each construction industry which the decision-maker controls.
Construction Industries' Contract Table	Description of all contracts made by construction industries controlled by the decision-maker.
Economic Boycott Status	Detail on all boycotts in which the decision-maker is either the party boycotting or the party being boycotted.
New Construction Table	Detail on all construction contracts in which the decision-maker is the contractee.
Land Summary	Tabular list of the location of parcels owned by a team, their assessed value, percent that is undeveloped and private, the taxes on undeveloped land, the percent publicly developed and undeveloped, the percent undevelopable because of topographical constraints, the utility capacity available and used.

Print-Out Section	Description
Loan Statement	Tabular list showing borrower, lender, interest rate, years remaining on the loan, the original principal, and the annual payment.
Financial Summary	A cash flow statement showing expenditures and income, a portfolio of conservative and speculative stocks, a balance sheet of assets and liabilities, and the amount which the decision-maker can borrow.

7. Social and Economic Summaries

Number of Levels of Economic Activity Controlled by Teams	A table listing the number of levels of each economic activity controlled by each team.
Employment Centers	Table showing the locations, number of job openings, number of Pl's hired, and salaries offered by Federal-State Employers; table showing, for each local government employer, the location of its employment center.
Economic Control Summary*	For each non-farm economic activity, this table shows its location, type and operating level of activity, production index (0-100) or occupancy rate (0-120), net income, and rate of return.

*This table prints for each economic team in alphabetical order.

Print-Out Section	Description
Social Control Summary*	For each class living on each parcel controlled by a single two-letter social decision-maker, this table shows the residence location, class, gross income per worker, family savings and total dissatisfaction (quality of life index).
Social Control Summary	By jurisdiction and by class, the number of Pl's controlled by each social decision-maker.
Economic Control Summary	This prints two graphs for each economic decision-maker, in alphabetical order. The first is, for up to ten rounds, the average net income from the team's economic activities each round, expressed as a ratio of the first round's net income. The second is a ten-round history of the average rate-of-return of the team's economic activities, expressed as a percent.
Social Control Summary	This prints two graphs for each social decision-maker, in alphabetical order. The first is a ten-round history of the average net income earned by each class which the team has controlled. The second is a ten-round history of the average quality-of-life index of each class which the team has controlled.

*This table prints for each social decision-maker in alphabetical order.

Print-Out Section	Description
8. Government Detail*	
Assessment Report	List of assessment ratios, special assessments and other policies set by the Assessor.
Water Department Reports	List of intake and outflow treatment plant locations, levels, types, capacities, operating costs, volume treated, income, intake and outflow point locations, prices charged to municipal water users, pollutant concentration in municipal effluent (for those districts which are sampled).
Sampling Station Report: Point Source Quality	For those economic activities whose effluent is sampled by the local government, this shows the volume of effluent and the concentration of each pollutant after any treatment.
Sampling Station Report: Ambient Quality	For any parcel on which the jurisdiction measures the quality of the surface water leaving the parcel, this output shows the concentration of each pollutant.
Utility Department Report	Tabular list of utility plants, their location, level, units installed from each plant, units served, total operating costs per unit, and income derived from charges. Also listed is the charge per utility unit to customers, undeveloped land and outstanding bonds.

*A department's output is printed for all jurisdictions before the next department's output is printed.

Print-Out Section	Description
Utility Department Finances	Summary of all current and capital revenues, expenditures, and new balances.
Municipal Services Department Report	Tabular list of MS locations, maintenance levels, value ratios, effective capacities, loading (units of capacity used), number PL and PM's working, and the MS use indexes. Also shown are the salary levels, contracts to purchase BG and BS, the locations of undeveloped land, and outstanding bonds.
Municipal Services Department Finances	Summary of all current and capital revenues, expenditures, and new balances.
Municipal Services Department Construction Table	For each MS construction or demolition, this shows the location of the construction firm, the MS location, the status of construction, the old and new level of the MS, the contracted price, the maintenance level, and the number of PL's and PM's assigned to work at the MS.
Planning and Zoning Department Report	Total jurisdiction population, total amount of parkland, outstanding bonds, and capital revenues, expenditures, and new balance.
School Department Report	Tabular data on school unit locations, levels, maintenance levels, value ratios, students attending, teachers, student-teacher ratios, and use indexes. Also data on undeveloped land, BG and BS contracts and cost of purchases, adult education summary, and several summary school statistics.
School Department Finances	Summary of all current and capital revenues, expenditures, and new balances.

Print-Out Section	Description
School Department Construction Table	For each school construction or demolition, this shows the location of the construction firm, the school building location, the status of construction, the old and new level of the school, the contracted price, the amount of federal-state aid used, the maintenance level for the school, and the number of PM's and PH's assigned to work at the School.
Highway Department Report	A financial report showing capital and current expenditures and revenues, outstanding bonds, a summary of maintenance levels and expenditures by road type, a summary of road conditions, a terminal status report, a list of undeveloped land, and a status report on available federal-state aid.
Highway Department Construction Table	For each road or terminal construction or demolition, this shows the construction firm, the location of the road or terminal, the status, the old and new level, the contracted price, and the dollar amount of federal-state aid used.
Rail Company Report	A financial report showing capital and current revenues and expenditures, outstanding bonds, employment costs, the amount and condition of rolling stock, the fare structure, passengers and total fares by route, and the number of passengers using each segment of each route.

Print-Out Section	Description
Bus Company Report	A financial report showing capital and current revenues and expenditures, outstanding bonds, employment costs, the amount and condition of rolling stock, the fare structure, passengers and total fares by route, and the number of passengers using each segment of each route.
Chairman Department Finances	This shows the welfare payment per unemployed worker and the financial summaries for municipal services, schools, highways, planning and zoning, utilities, and the chairman's account. Also included are the Chairman's outstanding bonds.
Tax Summary	Tabular list showing by the eight types of local tax bases, the dollar amount of the tax base, the tax rate, and the revenue generated.
Financial Summary	Tabular list, for each department, of current and capital appropriations, federal-state aid, total revenue, total expenditures and final surplus or deficit.

9. Summary Statistics

Demographic and Economic Statistics	Tabular list by jurisdiction of population and its characteristics, land usage, housing, employment, earnings, income from the national economy, outflows to the national system, and national business cycle effects.

Print-Out Section	Description
10. Maps	
Personal Goods Allocation Map	Map showing the locations and code numbers of all personal goods establishments, locations of all PG users, and the code number of the PG to which each PG user is assigned.
Personal Services Allocation Map	Map showing the locations and code numbers of all personal services establishments, locations of all PS users, and the code number of the PS to which each PS user is assigned.
Business Commercial Allocation Map	Map showing the locations and code numbers of all business goods and business services establishments, locations of all BG and BS users, and the code numbers of the BG and BS to which each BG and BS user is assigned.
Municipal Service Map	Map showing the locations of MS's and their districts, the locations of economic activities, the number of MS units drained by each economic activity and MS use indexes.
School Map	Map showing the locations of schools and their districts, school use indexes, and the number of children on each residence parcel attending public and private schools.
Utility Map	Map showing the locations of utility plants and their districts, the number of utility units installed on each parcel, and the number of utility units drained on each parcel.

Print-Out Section	Description
Water Usage Map	Map showing the locations of economic activities, the percent recycling at basic industries, and the type and level of basic industries' effluent treatment plants.
Water Quality Map	Map showing the locations of economic activities, the surface water quality on those parcels having surface water, and the pollutant which caused the water quality rating.
Municipal Treatment Plant Map	Map showing locations, types and levels of municipal intake and outflow treatment plants.
Municipal Intake and Outflow Point Map	Map showing locations of municipal intake and outflow points and the utility districts which they serve.
Surface Water Map	Map showing, for each parcel having surface water, the volume of water on the parcel, its rate of flow, and the percent of the surface area of the parcel consumed by water.
Farm Runoff Map	Map showing for each farm its type and where its runoff flows into the surface water.
River Basin Flood Plain Map	Map showing the locations of river basins, the dam priority of each river basin, and the flood susceptibility of each parcel in the river basin.
Farm Map	Map showing the location of each farm, its owner, its code number, the percent of each farm parcel which is in farm use, the type of farm, and its fertilizer level.

Print-Out Section	Description
Farm Assessed and Market Value Map	Map showing, for each farm parcel, its assessed and market value and the percent of the parcel which is in farmland.
Market Value Map	Map showing, for each privately-owned non-farm parcel, the market value of 100% of the land, the market value of the privately-owned buildings, and the total market value of the privately-owned land and buildings.
Assessed Value Map	Map showing, for each privately-owned non-farm parcel, the assessed value of the privately-owned land, the assessed value of the privately-owned buildings and the total assessed value of the privately-owned land and buildings.
Economic Status Map	Map showing the economic sector owner of each privately-owned non-farm parcel, its zoning, the type and level of economic activity, the level of utilities installed, and, for every parcel, the percent of the parcel which is privately-owned and undeveloped.
Highway Map	Map showing the locations and types of roads and terminals and the locations, types, and levels of non-farm economic activities.
Planning and Zoning Map	Map showing the zoning classification of those parcels which are zoned, the percent of each parcel which is parkland, and the percent of each parcel which is public, institutional land.

Print-Out Section	Description
Parkland Usage Map	Map showing the percent of each parcel which is in parkland or public institutional use, the population served by the park, and the park's use index.
Socio-Economic Distribution Map	Map showing, for each residential parcel, the type and level of housing and the number of Pl's in each class living there.
Demographic Map	Map showing the population (in 100's), percent occupancy, and quality index (QI) for all residential parcels, and the value ratio (VR) for all private non-residential developments.
Social Decision-Maker Map	Map showing, for each class living on a residential parcel, the social decision-maker which controls the class on that parcel.
Topographical Restriction Map	Map showing the percent of each parcel which is undevelopable due to topographical or other restrictions (e.g., mountains or military bases).
Government Status Map	Map showing the locations and levels of schools, municipal services, utility plants, roads, and terminals.

APPENDIX B

Terminal Allocation Output

Heavy industries, light industries, and business goods use terminals. Terminals represent major shipping and receiving points through which those businesses interact with the Outside system.

A business is assigned by the program to the terminal to which it has the least transportation cost. However, terminals have capacities, and a terminal's usage affects a business's perception of the transportation cost to get there. The allocation process is similar to the commercial process in that terminal users are assigned to terminals simultaneously and then reevaluate their choices in light of the new allocation. However, there is no Outside terminal. Since the only cost to a terminal user is the transportation cost, it uses the best terminal it can find, i.e., the one to which the transportation cost weighted by its usage is least. The user pays only the actual transportation cost.

The terminal output lists the location of each terminal user, the type of economic activity, and the number of terminal capacity units consumed by the user. It also shows, for each terminal, the terminal's code number, its location (terminals are located at intersections), and its development level. The capacity of a level one terminal is shown on the Master Table. A terminal's capacity is its development level times the capacity of a level one terminal.

The terminal output also includes a map showing the geographic distribution of terminal users and terminals. Each parcel on the map contains a single digit, which, if non-zero, is the code number of the terminal which the economic activity on that parcel is using. Terminals are identified by their single digit codes, are located at intersections, and are surrounded by asterisks.

Figure 4.6

TERMINAL DEMAND AND SUPPLY TABLE

CUSTOMERS

LOCATIONS	LAND USE	REQUIREMENTS
9626	CR	3000
9428	MF	2000
9828	TE	2000
9630	PA	3000
9830	BG	1139
9432	PO	3000
9632	MP	6000

TERMINALS

NUMBER	LOCATION	LEVEL
1	9531	2

Figure 4.7

TERMINAL ALLOCATION MAP

	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	26
30	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	28
32	0	0	0	0	0	0	0	0	0	0	0	0	1	*1* 1	0	0	0	0	0	0	*2* 0	0	0	30
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34
38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38
42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	40
44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	42
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	48
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110	112	114	52

APPENDIX C

EMPLOYMENT OUTPUT

The Full-Time Employment and Transportation Processes

The employment allocation process is run soon after the migration process. The number of workers living at each residence location is the number resulting from migration. Unlike the migration process, the employment process operates on all P1's; each P1 reconsiders all job openings each round. A whole P1 is hired at a time; there is no smaller unit in employment than a P1, even though a P1 is composed of many workers.

The factors involved in the matching of workers with jobs are each employer's salary offerings (salaries are set by class, one salary offered to each class), the transportation costs for workers to get to employment locations, the workers' relative education levels, the number of job openings in each class, where workers were employed in the previous round, and where workers are boycotting job openings. In general, if there are fewer workers than jobs, those employers offering the lowest salaries or located farthest from residences do not receive all of their needed employees and suffer production losses. Likewise, if there are more workers than jobs, those workers with the lowest education levels or located farthest from jobs are unable to find employment.

The process operates on one class at a time, high-income first and low-income last. Any high-income workers who cannot find jobs are first to be considered for middle-income jobs, and any middle-income workers who cannot find middle-income jobs are the first to be considered for low-income jobs. Thus, unemployment tends to be pushed toward the lower classes, although that is not always the case.

The first part of the employment process is the selection of the least cost route from each class living on a residence parcel to each employment location. When a population group selects a least cost route, it evaluates both the time (dollar value of time) and actual dollar cost of each mode and route. Modal usage is also a factor, since overcrowded modal usage causes delay in time. The workers perceive the previous round's mode and route usage. Each class is willing to pay up to a fixed percent of the income which it would earn at a job in order to get to the job.

After the least cost route has been selected from each P1's residence to each employment location, each P1 applies for the job which nets it the greatest amount of money

(salary offered less the transportation cost to get there). A P1 perceives a somewhat higher salary at its previous job than is actually offered there. If the net income which the P1 would receive at its old job is perceived to be highest, the P1 takes its old job back and looks no further. A P1 does not even consider taking a job which it is boycotting.

After all P1's who find their old jobs to be their best jobs have taken their old jobs, the remaining P1's seeking employment compete for jobs on the basis of their educational levels. Of the applicants for remaining job openings, an employer selects those with the highest education levels first. Those P1's who are not hired for their best jobs then seek employment at their next best jobs. The process is repeated until either all of the job openings in the class have been filled or all of the P1's in the class have been hired. There is one type of exception to the latter case: a P1 which cannot find a job within its maximum transportation range remains unemployed.

The employment process then operates on the next lower class, any P1's from the previous class being the first considered for jobs.

After the employment process has been run for all three classes, transportation routes and congestion are recalculated using the origins and destinations created in the employment process. All classes are assigned simultaneously to the least cost routes in time and money from their residences to their jobs, considering the previous round's usage of modes and routes. If there are any great changes in congestion between rounds after all have been assigned routes, the transportation process is run again, considering the new usage. The process is repeated until there is no great change in congestion between two successive iterations. P1's pay only the final actual dollar cost to travel; the time dollar cost is used for route allocation only.

The Full-Time Employment and Transportation Output

Detailed employment information prints for each class, low-class first and high-income last. Within a single class's output all of the information pertaining to those of the class living on the same residence parcel is printed together. The order in which the information for each parcel is printed is from left to right, top to bottom across the board.

The first column contains the coordinates of the residence parcel. The next column contains the location of

Figure 3.3

EMPLOYMENT SELECTION INFORMATION FOR HIGH INCOME CLASS

RESIDENCE LOCATION	EMPLOYER LOCATION	POPUL. UNITS	SALARY	TIME UNITS	AUTO COST	BUS COST	RAIL COST	ROUTE						
8628	UNEMPLOYED	0												
	9828	3	11000.	35.0	935.0	0.0	0.0	9727	9527	9327	9127	8927	8727	
8430	UNEMPLOYED	4												
8630	UNEMPLOYED	5												
	9828	2	11000.	25.0	985.0	0.0	0.0	9727 8731	9527	9529	9531	9331	9131	8931
8830	UNEMPLOYED	0												
	9230 (SC2)	2	10600.	2.5	310.0	0.0	0.0	9131	8931					
	9630	1	11000.	7.5	510.0	0.0	0.0	9531	9331	9131	8931			
	9832	10	11000.	5.0	410.0	0.0	0.0	9331	9131	8931				
9030	UNEMPLOYED	1												
	9228	4	10000.	2.5	0.0	0.0	0.0	9129						
	9828	16	11000.	20.0	785.0	0.0	0.0	9727	9527	9529	9531	9331	9131	
	9630	1	11000.	5.0	410.0	0.0	0.0	9531	9331	9131				
	9832	1	10000.	7.5	510.0	0.0	0.0	9731	9531	9331	9131			
8432	UNEMPLOYED	6												
8632	UNEMPLOYED	6												
	9828	1	11000.	25.0	985.0	0.0	0.0	9727 8731	9527	9529	9531	9331	9131	8931

each employer for which P1's in the class on the parcel work. The first row always shows the number of P1's who are unemployed on the parcel. For each other row, the output shows the number of P1's working at the employment location, the salary earned per worker, the total number of time units spent traveling to work, the total automobile cost paid per worker, the total bus cost paid per worker, the total rail cost paid per worker, and the route and modes which the population units take to work. All P1's of the same class living on the same residence parcel and working for the same employer take the same route and modes. The route printed is traced from employment location to residence location. The intersection at the start of travel, the intersections passed, the intersection at which a new mode is used, and the last intersection (that of the residence parcel) are listed in order. An intersection is a four or five digit number which may be preceded by a bus or rail route number if the P1 got off the bus or rail system at that intersection.

Next to some employment locations are parentheses containing the name of a government department or the notation 'FSE'. A government department has a parcel designated as its employment center. That parcel does not necessarily have government activity on it; it is merely used as a central hiring location because although a department can have facilities on several parcels, it hires centrally as a whole. The letters 'FSE' denote Federal-state employment centers such as state departments and federal installations. FSE is a catch-all category for miscellaneous local employment. An FSE only hires; it has none of the other characteristics of a business or local government department.

The Part-Time Employment Process

A social decision-maker can allocate time units for his population units to spend in part-time work. Social decision-makers realize that their population units seldom receive all the extra work for which time was allocated. As with the full-time employment allocation process, the P1's educational level is the most important factor in the assignment of part-time work units to extra work time allocation.

The supply of part-time work units, eighty of which are equivalent to one full-time job, is primarily determined by the levels of business activity in the system. Each business type has a fixed number of time units of part-time work for each class for each level of operation. In addition, a variable number of part-time work units (jobs) is provided by the School Department.

The school department in each jurisdiction provides public adult education according to the number of middle and high-income part-time work units it hires. This specification obviously can fluctuate considerably round-to-round.

Two lists -- one supply of and the other demand for part-time work units -- are created for each population class. The suppliers of part-time work units are ordered by the salary offered (proportional to full-time wage offered) with the highest salary placed first. Each entry on this list contains a location, a full-time salary per worker, and an amount of part-time work units available.

Each entry in the demand for units list is comprised of a residence group for which allowed time for extra work as defined by a parcel location, an average education level, and an average time allocation for extra work.* The number of P1's in each group is the final item of information. This list is ordered on the basis of average education level with the highest levels first.

For each complete pass through the list of residence groups, the part-time work allocation process attempts to assign by class ten units of extra work to each population unit which has an unfilled extra work allocation. The process continues until either all requests (unfilled allocations) are filled or until the supply of part-time work units is exhausted.

First, the residence group at the top of the list (i.e., the one with the highest education level of those groups who have not yet been assigned work in that particular pass) is examined. The number of P1's is multiplied either by ten or by a figure less than ten (if there are less than ten unfilled extra work time allocation units remaining) in order to obtain the group's request for part-time work units. For example, assume in the first pass that 6 PH's at 10026 have the highest education level and that the social decision-maker allocated 25 time units to extra work for each PH. The total demand for units of this group in the first pass is sixty (60). These population units will have their employment request of sixty part-time units met before any other high-income population units are considered.

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*P1's of the same class who live on the same parcel. Each P1 so grouped has averaged, and thus identical, characteristics such as education level and time allocated for extra work.

Once the request is determined, the job supply list is examined. For each potential work location, a shadow automobile transportation cost per worker is calculated. This value is subtracted from the salary per worker to obtain a net income per worker which is used to determine the best job. Units from this best job are assigned to the residence group up to the amount of their request. If that particular job has an insufficient supply of part-time units available, the remainder of the request must be met by the second best job, and so on.

After the job units are assigned to the particular residence group, their per P1 unfilled extra work time allocation units are decremented by ten (or the figure less than ten) and they are placed at the bottom of the residence group list. Of course, if the residence then has no more units to be filled, they are dropped from further consideration.

Subsequently, a different residence group appears at the top of the list and the assignment process proceeds in the identical fashion. This continues until either of the two mentioned termination criteria are reached. High-income population units may not be assigned middle or low-income part-time jobs, nor may middle take low or high, and so forth. Within an income class, the only case in which a P1 would receive a part-time job before another P1 with a higher education level is the case in which the latter's shadow transportation cost exceeded the remuneration expected from the particular job.

Note: The route which a P1 takes to a part-time job is the least-cost route, but road congestion is not a factor, and auto is the only mode allowed. The costs used in part-time job and route selection are the peak-hour transportation parameters, but a P1 pays a dollar cost and spends an amount of time travelling proportional to the number of time units spent in part-time work. For example, if a P1 spends 20 time units at a job to which the least full-time transportation cost is $200 and 4 time units, the P1 is charged 20/80 of those amounts, or $50 and 1 time unit.

The base auto cost used in the trip to full-time employment is used as a base cost in part-time employment, so a P1 also pays a portion of that base cost to get to part-time work.

The Part-Time Employment Output

One output is printed for each class, high-income first and low-income last. The first column shows the coordinates of the residence parcel. The second shows the location of one employer for whom the class on the parcel has been assigned part-time work. The location 'ADED' indicates that the class is working for a School Department's adult education program. The third column is the total number of part-time work units which the class on the parcel is filling at the employment location. The fourth contains the full-time salary offered per worker at the employment location. Since a full-time job is equivalent to 80 time units in part-time work, a class which filled 60 time units at a particular employer would receive 60/80 of the total salary paid to a P1 in its class working there full-time.

Figure III 3.4

PART-TIME WORK ALLOCATION FOR HIGH INCOME CLASS

RESIDENCE	EMPLOYER	TIME UNITS	SALARY
8830	9230	100	10600.
8830	9630	30	11000.
9838	9632	30	11000.
8836	9630	50	11000.
8836	9632	10	11000.
9638	9632	40	11000.
9834	9832	80	10000.
9834	9430	130	10500.
9438	9430	30	10500.
9034	9828	50	11000.
9436	9430	20	10500.
9436	9828	30	11000.
9436	9830	60	10000.
8430	9830	20	10000.

Employment Summary

This shows overall employment statistics for the simulated region. The list includes the following summary information for each class: the number of residence parcels occupied by the class; the number of Pl's employed in jobs of their own class; the number of Pl's taking jobs in the next lower class; the number of unemployed Pl's; the total number of Pl's in the class living in the simulated region; the total number of part-time units worked by the class; and the number of job openings for the class which were left unfilled.

This output is the single most useful section of the employment output for an observer to use in quickly evaluating the local employment situation.

Employment Centers

This output lists information concerning Federal-state employers and the locations of local government employment centers. The director specifies where Federal-state employers are located, how many Pl's they attempt to hir, and the salaries they offer. This output shows that information and the number of jobs which were actually filled at each Federal-state employment location.

The director can also designate locations from which a local government department hires. If the director does not designate a parcel as a department's employment center, that department has the whole region as its hiring location. That is, a prospective employee has no location to which to travel for work. An employee's transportation time and dollar cost is the average automobile time and dollar for workers in the region. He does not contribute to road usage because he has no specific destination.

Figure 3.7

EMPLOYMENT SUMMARY

	LOW INCOME	MIDDLE INCOME	HIGH INCOME	ALL CLASSES
NUMBER OF RESIDENCES	20	35	31	52
PI'S EMPLOYED AT THIS LEVEL	173	236	274	683
PI'S EMPLOYED AT LOWER LEVEL	0	79	42	121
PI'S UNEMPLOYED	41	0	0	41
TOTAL POPULATION UNITS	214	315	316	845
PART-TIME UNITS WORKED	1304	1648	1008	3960
NUMBER OF JOBS STILL AVAILABLE	0	0	0	0

Figure 7.2

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TWOCITY
EMPLOYMENT CENTERS ROUND 2

****

FEDERAL STATE EMPLOYERS

EMPLOYER LOCATION	JOB OPENINGS LOW	MIDDLE	HIGH	JOBS FILLED LOW	MIDDLE	HIGH	SALARY OFFERED LOW	MIDDLE	HIGH
9432	5	4	3	5	4	3	2600	5200	10400

LOCAL GOVERNMENT EMPLOYERS

DEPT. AND JURIS.	EMPLOYMENT CENTER
RAIL	9430
BUS	9430
MS1	9430
SC1	9430
MS2	9230
SC2	9230

APPENDIX D

COMMERCIAL OUTPUT

The Commercial Allocation Process

All people and businesses and two government departments purchase goods and services each round in order to function. People and residence owners (for residential maintenance) purchase from Personal Goods (PG) and Personal Services (PS) establishments; businesses, schools, and municipal services purchase from Business Goods (BG) and Business Services (BS) establishments. The procedures for allocation of PG and PS buyers to sellers are identical. The procedures for allocation of BG and BS buyers to sellers are similar to the PG and PS allocation and identical to each other. The computer program performs the entire allocation process, but is affected by player decisions.

Each user of goods and services requires a certain number of consumption units. A consumption unit is an expression which represents a quantity to be purchased, regardless of what items in reality comprise that quantity. The quantity of goods or services which a seller can provide is also expressed as a certain number of consumption units. Each seller of goods or services sets a price which must be paid for each consumption unit purchased at his commercial establishment. Usually PG and PS prices are similar and BG and BS prices are similar. The quantity which each buyer of goods and services must obtain is indirectly derived from player decisions by the computer program. The program relates the local supply to that demand in the commercial allocation process, which simulates the decision of each buyer as to where it will purchase its required goods and services.

The PG-PS allocation process is run before the BG-BS allocation process. A description of PG allocation suffices as a PS description.

The buyers of PG are each class living on each residence parcel and each residence unit incurring maintenance. Pl's buy for themselves to live; residence owners buy goods for maintenance only. All of the same class living on the same residence parcel purchase at the same PG; a residence owner buys all of a single residence parcel's maintenance at the same PG.

Each buyer of PG attempts to purchase from the PG establishment at which it can obtain its goods most cheaply. The buyer's cost per consumption unit (CU) is the cost per CU at the establishment plus the least transportation cost

per CU to get from the buyer's location to the establishment. There are two additional factors in a buyer's perception of a seller's price. One is the buyer's bias toward shopping where it shopped in the previous round. The other is the buyer's bias against shopping at an establishment which was overused in the previous round, i.e., an establishment at which more CU's were sold than the establishment could adequately provide. There is no absolute limit on the amount which a PG can sell, but as it sells more than its effective capacity to provide, its service deteriorates.

Each buyer selects the PG establishment at which it incurs the least perceived total cost. A buyer does not even consider selecting a PG which it is boycotting. All buyers choose simultaneously, and then reevaluate their selections in light of the new usage. The evaluation process is repeated until no commercial establishment changes its usage on two successive reevaluations. The cost which a buyer pays is the actual price at the PG which it selects and the actual least transportation cost to get to that PG.

There is one competitor for local PG establishments: the Outside. The Outside is treated the same as any other PG in the allocation process, but its price is higher than the typical local price (see Master Tables for Outside prices and typical local prices). There is, however, no transportation cost to shop Outside, and no crowding effect. A PG buyer purchases Outside if the Outside price is less than its least perceived local cost to shop. The Outside has unlimited capacity.

Output

There are four main parts to the commercial output:

PERSONAL GOODS ALLOCATION SUMMARY
PERSONAL SERVICES ALLOCATION SUMMARY
BUSINESS GOODS ALLOCATION SUMMARY
BUSINESS SERVICES ALLOCATION SUMMARY

Again, an explanation of PG applies, to a great extent, to the other allocations.

The first section concerns PG establishments. Each PG has a code number. The Outside is always code number one. In the row beside the code number are the location of the PG, its owner, development level, effective capacity (in CU's), the number of CU's sold, the price charged per CU, and the PG's gross income (price per CU times CU's sold). The Outside has no owner, level, or capacity.

Figure 4.1

TWOCITY
PERSONAL GOODS ALLOCATION SUMMARY ROUND 2

PERSONAL GOODS

NUMBER	LOCATION	OWNER	LEVEL	CAPACITY	CAPACITY USED	PRICE/CU	GROSS INCOME
1	OUTSIDE				4144	13000	53872000.
2	9230	E	1	13148	13822	10000	138220000.
				TOTAL	17966		192092000.

CUSTOMERS

PERSONAL GOODS ASSIGNED TO	LOCATION	CLASS OR LAND USE	DECISION MAKER CONTROLLING	CONSUMPTION UNITS	TRANSPORTATION COST	PURCHASE COST	TOTAL COST
2	9422	RA	B	1	1175.	10000.	11175.
2	9422	LOW	F	21	24675.	210000.	234675.
2	9422	MID	C	28	32900.	280000.	312900.
2	9622	LOW	D	42	49350.	420000.	469350.
1	9822	LOW	D	84	0.	1092000.	1092000.
1	10022	LOW	D	190	0.	2470000.	2470000.
2	9424	RA	C	2	1850.	20000.	21850.
2	9424	LOW	F	21	19425.	210000.	229425.
2	9424	MID	C	28	25900.	280000.	305900.
2	9624	RB	F	52	48100.	520000.	568100.
2	9624	LOW	D	590	545750.	5900000.	6445750.

The second section provides detail on all purchases of PG. The table contains one row for each purchaser of PG. The list is ordered by residence parcel location, from left to right and top to bottom across the board. For a single parcel, the list is in order of residence, low-income, middle-income, high-income. The first column contains the code number of the PG at which the buyer is shopping. The second column contains the coordinates of the residence parcel and the third identifies the type of buyer on the residence parcel (RA, RB, RC, LOW, MID, or HIGH). Next is a single letter identifying the decision-maker controlling the residence or class. For a residence, the letter denotes an economic decision-maker; for a class, the letter denotes a social decision-maker.

The number of consumption units which the buyer has obtained is the fifth item of information. The number of CU's required is calculated by the program but is affected by player decisions. The calculations are different for residential maintenance than for P1's. A residence depreciates each round in response to several factors: normal depreciation (fixed), quality of local municipal services, sufficiency of local water for fire protection, and floods. Only the normal depreciation is not responsive to local conditions. As a residence depreciates, it becomes less attractive to people seeking housing. A residence owner can offset depreciation by setting a maintenance level for the residence. When the residence depreciates below that maintenance level, the program automatically calculates the number of PG and PS units required to restore the residence to the maintenance level. The values of the factors which affect depreciation and the number of PG and PS units required for each 1% maintenance are shown on the Master Tables. For example, suppose that an RB had a quality index of 70 and a maintenance level of 70, and that the Master Table showed that RB requires 4 PG units and 2 PS units per 1% maintenance. Suppose that the residence depreciated a total of 3% (3% of 100, not of 70). The RB would automatically purchase 3 x 4, or 12 units of PG, and 3 x 2, or 6 units of PS.

The total consumption of a class living on a single residence parcel is a function of three things: the class, the amount of time allocated to recreation, and the number of P1's in the class living there. The fixed number of PG and PS units required by a P1 in each class are shown on the Master Table. The amount of time allocated to recreation is set by the decision-maker controlling the class on the parcel. The Master Table shows the number of PG and PS units which a P1 must purchase for each time unit spent in recreation. Suppose that there are 6 PM's on a parcel and that they have allocated 10 time units to recreation.

Suppose further that the Master Table shows that a PM requires 28 PG and 11 PS units per round, and .05 PG and .05 PS units per time unit in recreation. The 6 PM's would require:

$$28 \times (10 \times .05) \times 6 = 84 \text{ PG units, and } 11 \times (10 \times .05) \times 6 = 33 \text{ PS units.}$$

The transportation cost, the sixth column, is the total transportation cost which the buyer pays to obtain PG. The transportation cost is always zero if the buyer purchases from the Outside. The transportation costs printed for residences are dummy costs used for the purposes of assigning residential maintenance purchases to PG establishments; no one ever pays that cost.

The last two columns show the total purchase cost paid by the buyer to the PG establishment and the total cost paid by the buyer for the personal goods and transportation (columns six plus seven).

The Personal Services Allocation Summary contains the identical types of information regarding detail on buyers and sellers of personal services.

The Business Goods and Business Services summaries are also identical regarding economic sector buyers and sellers, with a few minor exceptions in the economic sector. For one, PG and PS buy from BG and BS in response to their sales resulting from the personal commercial allocation. The Master Table shows how many units of BG and BS a PG or PS must purchase for each CU which it sells.

A basic industry requires a fixed number of BG and BS units each round. The fixed number is the number which the Master Table shows as being required for a level one of the industry type. That amount times the industry's level is the industry's fixed consumption.

Businesses depreciate annually due to several factors. Like residences, businesses may offset depreciation through maintenance. The Master Table shows the number of BG and BS units required per 1% maintenance for each business type.

Business Goods and Business Services are the only business types which never pay for operating costs and maintenance costs locally. They purchase from the Outside.

The major difference between the BG-BS and PG-PS allocation processes is that BG and BS can have contracts to provide local schools and municipal services departments with their required goods and services. A department can

Figure 4.5

GOVERNMENT CONTRACTS

BUSINESS SERVICES	DEPARTMENT	CONSUMPTION UNITS	COST
1	MS1	3	390000
1	MS2	8	1040000

contract with several local goods and services establishments for up to a total of 100% of its requirement. If less than 100% of a department's requirement is contracted locally, then the rest is automatically purchased from Outside at the Outside price. Government contracts with BG and BS establishments are made by players; they enter into the commercial allocation process only in that they consume BG and BS capacity before the other BG-BS buyers select shopping locations and thus decrease a BG's or BS's remaining capacity. Sellers to government are assured of government purchases. The number of units which a department consumes is the sum of the operating needs of its facilities (number of levels times a fixed requirement per level) and its maintenance requirements. Both BG and BS allocation summary outputs have a table showing where government departments are buying BG and BS, how many units are consumed by each department, and the total income to the BG or BS establishment for those sales.

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